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A LONGITUDINAL ASSESSMENT OF PRESCHOOL CHILDREN IN HAPTIC LEARNING. FINAL REPORT.

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RECENTLY MUCH ATTENTION HAS BEEN FOCUSED ON THE SUBJECT OF CONCEPT FORMATION IN CHILDREN. THE DEVELOPMENT OF SPATIAL PERCEPTION IS AN IMPORTANT ASPECT OF THIS, AND ONE IMPORTANT PART OF SPATIAL PERCEPTION IS HAPTIC PERCEPTION--THE RECOGNITION OF OBJECTS BY TOUCH. THIS STUDY IS A LONGITUDINAL INVESTIGATION OF THE RETENTION OF HAPTIC ABILITIES DEVELOPED IN THE COURSE OF A 3-MONTH TRAINING EXPERIMENT, REPORTED IN ED 010 126. THE FINAL TEST OF THAT STUDY WAS USED AS THE PRETEST FOR THE LONGITUDINAL STUDY. TESTS WERE GIVEN TO THE PARTICIPANTS OF THE EARLIER STUDY 6 MONTHS AND 12 MONTHS AFTER ITS COMPLETION. OF THE 144 SUBJECTS OF THE EARLIER STUDY, 131 COMPLETED RETESTING. THE AGES OF THESE SUBJECTS RANGED, AT THE BEGINNING OF THE EARLIER STUDY, FROM 36 TO 71 MONTHS. THE SUBJECTS CAME FROM MONTESSORI AND NON-MONTESSORI PRESCHOOL PROGRAMS AND HAD BEEN DIVIDED INTO EXPERIMENTAL AND CONTROL GROUPS WHICH RECEIVED EITHER INDIVIDUAL OR GROUP INSTRUCTION. FIVE TESTS OF HAPTIC PERCEPTION WERE USED. IN EACH TEST THE SUBJECT HANDLED PLYWOOD FORMS THROUGH AN OPENING IN A SCREEN AND WAS THEN ASKED TO DO SUCH THINGS AS NAME THE OBJECT, DESCRIBE IT, OR DRAW IT. ANALYSES IN WHICH THE PRETEST SCORES WERE CONTROLLED INDICATED THAT RETENTION WAS NOT STRONGLY AFFECTED BY THE TYPE OF PRESCHOOL, THE TYPE OF INSTRUCTION, CHRONOLOGICAL OR MENTAL AGE, OR SEX. EXAMINATION OF THE SCORES OVER THE 12-MONTH PERIOD SHOWED THAT ALTHOUGH THE EXPERIMENTAL SUBJECTS SCORED CONSISTENTLY HIGHER, THE CONTROL SUBJECTS HAD HIGHER CHANGE SCORES. THIS SEEMS TO HAVE RESULTED FROM A LOSS OF PROFICIENCY IN HAPTIC ABILITIES BY THE EXPERIMENTAL SUBJECTS, COUPLED WITH SOME DEVELOPMENT OF HAPTIC ABILITIES BY THE CONTROL GROUP AS A RESULT OF MATURATION. (DR)

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Sister John Vianney Coyle, S.A.
Sister Josephina Concannon, C.S.J.

February 1968

The research reported herein was performed pursuant to a contract with the Office of Education, U. S. Department of Health, Education, and Welfare. Contractors undertaking such projects under Government sponsorship are encouraged to express freely their professional judgment in the conduct of the project. Points of view or opinions stated do not, therefore, necessarily represent official Office of Education position or policy.

Boston College - School of Education

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CHAPTER I

INTRODUCTION

In recent years Bruner, Goodnow, and Austin (1956), along with a number of other psychologists have focused considerable attention on the subject of concept formation. Since perception is fundamental to the formation of concepts, an understanding of the development of human perceptual abilities is essential for a thorough understanding of concept formation. Eminent developmental psychologists have stated that

> . . . it is clear that if the development of various aspects of child thought can tell us anything about the mechanisms of intelligence and the nature of human thought in general, then the problem of space must surely rank as of the highest importance.
>
> Reprinted from The Child's Conception of Space by
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> Routledge and Kegan Paul. Published 1956.

According to Gibson and Olum (1960), however, very little is known about the perceptual world of the child, and investigations of space perception, other than visual, are especially rare in children. Space perception includes essential aspects of form perception.

In The Child's Concpetion of Space, Piaget and Inhelder devoted some attention to the development of haptic perception in children. Haptic perception is defined as the ability to recognize objects by the sense of touch alone in the absence of visual stimulation. A more detailed explanation of the significance of haptic abilities in the study of spatial perception is given in the following passage:

> The term (haptic perception) which has become general is nevertheless incorrect; for these so-called perceptions go far beyond the limits of the purely perceptual and usually presuppose the translation of tactile perceptions and movements into visual images. But quite apart from the question of terminology, it is precisely this mixed character which pertains to the fact of "haptics" that will interest us here. For it gives us the opportunity of observing in the raw the actual process of development from the perception of shapes to their representation in children.
>
> Reprinted from The Child's Conception of Space by
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> Routledge and Kegan Paul. Published 1956.

The few studies that have been concerned with haptic or tactual perception have indicated that this type of perception undergoes progressive development in young children. Among these studies, those reported by Piaget and Inhelder were the most detailed, but, characteristically, the Geneva experiments did not encompass a large number of subjects and failed to produce statistical verification for findings. Efforts to improve the experimental design of Piaget and Inhelder's research have been made by Page (1959), Lovell (1959), Fisher (1965), and Concannon (1966). The last study, conducted with young children, was unique in that it provided a program of learning experiences involving the use of haptic perception.

Statement of the Problem

The research reported here attempts to lend to the Concannon study a longitudinal aspect in keeping with Wohlwill's recommendation that more longitudinal studies be conducted to investigate the development of cognitive processes (Wohlwill, 1964). Sears and Dowley (1963) also advocated longitudinal or follow-up studies on experiments with young children to test the stability of effects.

The intention of the present study was to assess the retention of learning acquired and the stability of haptic abilities attaianed, in the experimental program of lessons, six months and twelve months after the termination of the program. To this end, scores obtained by subjects in the final test of the Concannon experiment, which became the pretest of the current study, were compared with scores obtained on repetitions of the same test six months and twelve months later. These data were then studied in their relationship to the following factors: type of treatment received in the Concannon experiment, type of instruction received in the haptic learning program, type of preschool attended (modified-Montessori or non-Montessori), sex, session attended in the preschool program, chronological age, mental age, years of schooling received prior to participation in the learning experiment, and time elapsed since completion of the experiment.

Limitations

Among the limitations inherent in the present study, the first is the size of the sample, circumscribed by the original experiment and further reduced by the attrition of thirteen subjects who could not be contacted for follow-up testing. Other limitations are: the possible effects of fatigue when testing had to be done in one sitting; the under-developed motor control of some subjects which affected performance on Test 4, requiring the drawing of geometric shapes perceived haptically; and the extent of rapport between examiner and subject.

Significance of the Problem

Especially in recent years, the preschool program in the United States has evoked increasing interest from educators and psychologists as well as from parents of all socioeconomic classes. Led by the experimental schools of universities and teachers' colleges, many preschool programs have evolved from a fundamental belief in the value of rich, spontaneous, and informal learning experiences guided by a minimum of structuring. The learning experiences provided by such programs are directed toward the total development of the child--socially, intellectually, physically, and emotionally (Todd and Heffernan, 1964)--and are seldom subjected to formal and objective evaluation.

Preschool programs have also developed within all-day nurseries. Originally founded for the purpose of providing custodial care for the young children of working mothers, many day-care centers have expanded their objectives to include social and learning activities aimed at fulfilling the needs of children who spend much of their time away from parental supervision and ordinary home experiences.

Other preschool programs have been conceived and developed as downward extensions of the elementary school program. In these classes, children participate in a planned program combining music, literature, and other learning experiences aimed at "readiness" or preparation for first grade work.

During the past twenty years in America there has been a revival of the Montessori type of preschool class with its highly structured program, emphasizing individual instruction and learning in an atmosphere of quiet concentration. The Montessori curriculum gives special attention to the "education of the senses," including repeated exercise in tasks devised to aid the child in refining his differentiation of tactual stimuli (Montessori, 1912). Montessori directives also recommend training children in the tactual perception of geometric froms as an adjunct to visual recognition (Montessori, 1914).

On the post-test of the Concannon experiment, subjects from a modified-Montessori class were significantly superior to subjects from traditional preschool programs. The present study sought to determine whether this superiority remained after the lapse of a period of six months and a period of twelve months.

Within the past three years, the allocation of Federal funds for Head Start programs has further emphasized the importance attached to the learning experiences of early childhood. Research on young disadvantaged children suggests that the young child who, before entering school, has experienced severe limitations of play areas and play materials has failed to develop perceptions of space and form that are adequate as foundations for later learning (Deutsch, 1963a; 1963b). As yet, however, the paucity of research on the spatial and perceptual abilities of young children, in general, provides little basis for comparison and determination of the particular deficiencies of children from deprived environments.

A recent report from the Educational Policies Commission advocated education for all children beginning at the age of four, since

> . . . the first four or five years of a child's life are the period of most rapid growth in physical and mental characteristics and of greatest susceptibility to environmental influences.
>
> Reprinted from Universal Opportunity for Early Childhood Education by the Educational Policies Commission by permission of the National Education Association. Copyright 1966.

Bloom's research similarly indicated that, by the time a child has attained the age of four, he has already developed fifty per cent of his mature intelligence and will develop an additional thirty per cent by the time he reaches the age of eight (Bloom, 1964).

Despite widespread interest in early childhood education, however, little research is available to indicate how much specific learning, acquired in a preschool program, is retained over periods of several months or a year. According to the Encyclopedia of Educational Research, learning implies retention since the only way learning can be known is through the effect it has on later performance and this effect is mediated by retention (Monroe, 1952). In their review of retention studies, Sterrett and Davis (1954) observed that retention studies reflect both the value of the objectives sought in the instruction and the efficiency of the methods employed. Therefore they considered such studies to be valid means for evaluating the efficacy of instructional methods.

Review of Related Research

In her didactic lessons, Montessori (1912) advocated training in tactual perception for young children and prescribed exercises in which the child would be taught to trace outlines of objects with his fingers. Montessori (1914) maintained that children trained in tactual exercises soon recognized geometric forms although they had been unable to master this type of recognition by sight alone. However, Montessori's work was never tested by empirical means and, thus, one relies mainly upon her written statement regarding the validity of her practices.

The extent to which such directed practice benefits children remains, even today, an unanswered question. Piaget (1964) has expressed doubt that exercise in perception and memory will accelerate the development of stages in children's thinking. Wohlwill (1964), however, has stated that acceleration of thedevelopment of cognitive stages is not a necessary, or even a desirable, objective in exercises in perception. Rather, he considered a broad background in perceptual experiences as an advantageous basis for later learning. Zaporozhets (1965) asserted that the development of the child's perception takes place under the influence of practice and learning and that, in the learning process, the child assimilates a system of sensory measures generally accepted by his culture. In addition the child learns to designate particulars in his environment by means of language, and later these dsignations are used in his perceptive activity to analyze and reflect reality.

Having examined the nature of perceptual learning, Gibson and Gibson (1955) concluded that the question of whether training can affect favorably a man's perception of the world around him is a very productive field for theory and experimentation.

Under the name "stereognosis," haptic perception has been familiar for some time to neurologists who have considered impairment of this ability as an indication of cerebral lesions in adults and older children. Benton and Schultz (1949) found that the stereognostic capacity shows some growth within the age range of 3 years to 6 years, and that this capacity cannot be expected to reach its full perfection in the individual until the age of 6 years.

Gibson (1962) distinguished between sensations arising from active touch and those received passively from cutaneous stimulation. He maintained that, when vision and touch are conceived as channels for information-pickup, since they have exploratory sense organs, they have much in common.

Many studies of tactual perception have reported work with blind subjects. Worchel (1951) and Ewart and Carp (1963) studied tactual form perception among blind and sighted subjects with mean chronological ages of approximately 14 years and

11 years, respectively. Blind and sighted subjects were equally efficient in form recognition. Worchel, however, found that sighted subjects and those who became blind after the age of six were superior to subjects blinded before the age of six in the reproduction and description of tactually perceived forms. Ewart and Carp (1963) found a significant relationship between high IQ and tactual recognition of form among blinded subjects. Subjects with higher IQ's were superior in form recognition, but no such relationship was found among sighted subjects. Drever (1955) tested early blind, late blind, and sighted subjects, ranging in age from 9 years 8 months to 19 years 6 months on a task which required them to select by tactual exploration the shape which two wooden blocks would form when placed together. Sighted subjects were most successful, with late blind and early blind subjects following in that order. Differences between groups were all significant at the .01 level. Early blind subjects, however, were most successful in returning pegs to a pegboard which had been rotated 180° from its original position. On the basis of his experiments, Drever hypothesized that some of the visual and other skills involved in space perception are so complex that they require a long period of training and mastery of simple skills rather than a nervous system at a certain level of maturity.

Piaget's Work and Its Influence. The most detailed examination of haptic perception has been done by Piaget and his associates at Geneva and reported in *The Child's Conception of Space*. The developmental stages of haptic perception recognized by Piaget and Inhelder (1956) can be summarized in the following manner:

Stage I-A	
Age 2 years 6 months to 3 years 6 months	Tactual exploration relatively passive. Familiar objects recognized but not shapes.
Stage I-B	
Age 3 years 6 months to 4 years	Beginnings of the abstraction of shape. Topological shapes recognized. Representation by means of drawing possible, but lags behind identification by choice.
Age 4 years to 4 years 6 months	Beginnings of crude differentiation of rectilinear (square, rectangle, etc.) from curvilinear (circle, ellipse, etc.) shapes. Shapes not differentiated among themselves.

Stage II-A Age 4 years 6 months to 5 years	Progressive differentiation of shapes according to their angles and even their dimensions. Tactual-kinesthetic exploration shows signs of search for significant clues to identity. Still a slight gap between recognition and drawing, but the latter is becoming more precise.
Stage II-B Age 5 years to 6 years	Recognition of more complex forms. Exploration becomes more active, but it is not always systematic.
Stage III Age 6 years to 7 years and above	Methodological exploration. Drawing shows exact correlation with power of recognition.

For Piaget and Inhelder (1956) the term "haptic perception" usually implied the translation of tactual perceptions into visual imagery. Lowenfeld (1945), however, hypothesized that within the sighted population there are visually-minded individuals who use their eyes as the main intermediaries for their sense impressions of space and form and haptically-minded individuals who are more concerned with perceptions that derive from haptical experiences than with those deriving from sight. In a completely darkened room, the visually-minded individual would tend to translate tactual explorations of objects into visual imagery, while the haptically-minded person would be content with mere tactual perceptions and would probably proceed to the formation of visual images only if this were necessary to report on objects perceived in visual terms. Lowenfeld described 47 per cent of the subjects in his experiment as being clearly visual, 23 per cent as haptic, and 30 per cent as unidentifiable.

While Piaget's probing of unique aspects of child development has won commendation from psychologists and educators, the absence of conventional design and statistical analysis in his experiments has been an object of criticism. Piaget's work has inspired additional studies in haptic perception in England and Russia and, to a lesser extent, in America.

Studies in England. Studies conducted by Lovell (1959), Page (1959), and Fisher (1965) have centered primarily on verifying the stages of haptic perception as presented by Piaget and Inhelder (1956) and have attempted to improve on the Geneva experimental design. In general, the results of these experiments indicated that haptic perception does develop according to the sequence of stages reported in The Child's Conception of Space, but the ages at which children attain these stages may differ, i. e., children in England attained these stages at an earlier age than did those in Geneva. Lovell noted, however, that younger children recognized Euclidean shapes having curved edges as easily as topological shapes.

In one phase of his experiment Fisher (1965) assigned nonsense syllable names to linear and topological shapes and trained an experimental group of subjects to recognize the shapes by sight and nonsense syllable names. In subsequent haptic tests, experimental subjects excelled control subjects in the recognition of linear shapes, but were slightly, although not significantly, lower than control subjects in the recognition of topological shapes. From these findings, Fisher argued that, contrary to Piaget's conclusions, linear shapes are identified as early and as easily as topological shapes when identifying names are equally available for both classes.

Fisher's results from the use of identifying names showed some resemblance to findings made in several studies of visual discrimination with American preschool children. Cantor (1955) found that the possession of names for the stimuli in a learning task enhanced performance on that task. Norcross and Spiker (1957) reported similar results. When results of a later experiment indicated that the advantages of name-learning for stimuli occurred only in the later stages of learning, Spiker and Norcross (1962) suggested that the possession of names for stimuli made it easier for the subject to remember which was the correct stimulus in a discrimination task.

An experiment by Hermelin and O'Connor (1961), while not stemming directly from the work of Piaget and Inhelder, raised some intersting questions regarding the relationship between haptic abilities and mental age. Subjects were normal children, with a mean C. A. of 5 years and a mean M. A. of 5.4 years, and retarded children with a mean C. A. of 12 years and a mean M. A. of 5.4 years. In same-modality and cross-modality tests involving vision and touch, there were no significant differences between or within groups, with one exception. Among retarded subjects, results from manual exploration followed by manual test were significantly better than scores on all other tests for both retarded and normal subjects. The small number of subjects and the absence of a normal control group of C. A. 12 years limited the applicability of these findings, but the results indicated that mental retardation does not necessarily affect haptic perception.

Studies in Russia. Within recent years several Russian psychologists have given attention to the roles of vision and touch in the perceptual development of young children. Several of these experiments have been summarized by Zaporozhets (1965), who reported that, when asked to examine objects tactually with eyes closed, children at the age of about 6 years traced the outline of the object with their fingers, while younger children did not. In later experiments for visual recognition of objects previously examined tactually, the six-year-olds who had traced figure outlines made substantially fewer mistakes than did younger children.

Studies in America. With the exception of Concannon's experiment, the few studies of haptic perception conducted in America have not been concerned with replicating Piaget and Inhelder's experiments. Cross-modality experiments have been reported by Cutsforth (1933) and more recently by Birch and Lefford (1963), Krauthamer (1964), and Lobb (1965).

Cutsforth (1933) tested sighted subjects in size perception and found that the discrepancy between tactual perception of size and visual perception of the same size was greater when the tactual perception was made with the object in the vertical position rather than in the horizontal position. From his experiments, Cutsforth concluded that, in sighted individuals, tactual perceptions depend fundamentally on visual perceptions.

Birch and Lefford (1963), working with children from 5 to 11 years of age, studied equivalent relationships among visual, haptic, and kinesthetic modalities, using geometric forms from the Seguin Form Board. They concluded that five-year-old children were able effectively to equate visual and haptic information in their perception and that, beyond the eighth year, the visual-haptic function showed no improvement with age.

Tactual perception in Krauthamer's experiment differed noticeably from the "active touch" described by Gibson (1962) and ordinarily used in studies of haptic perception. Designs were either traced on the palm of the subject's hand with a stylus or were pressed into the palm by means of a metal die. Cross-modal transfer was significantly more successful under the first condition than under the second.

Lobb (1965), working with eighth grade pupils, found vision superior to touch in the discrimination of random-shaped forms. Lobb also found that in cross-modality tasks, the sequence of vision to touch was superior to the sequence of touch to vision.

Using as his experimental material plywood sheets into which tacks had been hammered to form a design, Gollin (1960) found adults superior to primary grade children in tactual discrimination tasks. Klein (1964) examined the relative dominance of texture and form in haptic perception among grade school children and found that, with development, tactual perceptions included both the texture and the form dimensions of tactual stimuli in an integrated fashion. With first grade children as subjects, Pick (1965) studied the improvement of visual and tactual form discrimination using 1 x 1 inch metal squares on which were raised letter-like forms. Results indicated that training in discrimination did not affect transfer of learning.

Gibson (1963) reviewed several studies in tactual perception and discrimination.

Concannon's Experiment. Concannon (1966) studied the development of haptic abilities in preschool children who participated in a learning program which included instruction in tactual exploration and in identification, description, and drawing of geometric forms studied haptically and visually. Lessons were taught through a multisensory approach requiring the use of sight, hearing, and touch. Haptic perception was given particular emphasis. A more detailed description of the Concannon test of haptic abilities appears in Chapter II. The experiment was conducted over a period of more than three months and was also used to make comparisons beyond the development of haptic perception. Among the additional factors studied were the relative effectiveness of group vs. individual instruction and participation in a modified-Montessori vs. a non-Montessori preschool program. Differences which attained statistical significance in the analysis of data included:

1. Subjects from non-Montessori classes were superior to subjects from the Montessori classes in the pretest of the experiment.

2. Subjects from the Montessori classes made greater gains than subjects from the non-Montessori classes during the course of the experiment.

3. Subjects from the Montessori classes were superior to subjects from the non-Montessori classes on the final test of the experiment.

4. Subjects who received experimental treatment were superior to control subjects on the final test of the experiment.

5. On the final test of the experiment girls excelled boys on three tests, but boys were superior to girls on the test which required the drawing of haptically perceived forms.

No significant differences were found between subjects receiving individual instruction and those receiving group instruction. Increase in previous years in school and in mental age showed no appreciable effect when compared with differential gain scores. Increments in chronological age, however, had a significant and positive effect on performance in the three tests of haptic abilities which did not require verbalization on the part of the subject.

The Retention of Learning. Beginning with the experiments of Ebbinghaus (1885), memory, or retention, has been one of the earliest and most persistently investigated subjects in the history of psychological research (Bryan, 1934). Philippe (1897) introduced an aspect of haptic perception into an early experiment in retention. Each of five relatively common objects was presented tactually to the subject whose eyes were closed. After the subject had made an extensive tactual exploration of the object, he drew a picture of it, and only then was he permitted to examine the object visually. Retention was measured by having subjects draw the objects from memory at intervals of from two to four weeks over a period of several months.

Davis (1945) pointed out that learning includes both acquisition and retention, since without the ability to retain the effects of previous training in learning experiments, there could be no progress during successive periods of practice.

Retrwntion may be measured by the methods of relearning, recall, and recognition (Davis and Moore, 1935). Bartlett (1950) clearly distinguished between recognition and remembering in this way. In recognizing, the psychological material which persists from a previous experience matches some immediately present sesnory pattern. In remembering, the psychological material which persists is itself capable of being described. According to Davis (1945) the scientific study of retention involved: (1) measurement of initial acquisition; (2) allowance of a definite lapse of time in which there had been no formal study or review; and (3) remeasurement to determine the amount retained after the intervenient period.

The material for retention studies included nonsense syllables, word lists, selections of prose and of poetry, word and object associations, picture and object associations, classroom learning, and motor learning. McGeoch and Irion (1929) summarized studies evidencing long-term retention, but the majority of studies have examined retention over relatively short time intervals, so that there is little precise information available on the limits of retention (Hovland, 1951).

Davis and Moore (1935) summarized sixty-one studies of the retention of both meaningless and meaningful materials, based upon the three major methods of measurement: relearning, recognition, and recall. The curves of retention from these studies showed a large percentage of forgetting immediately after learning, followed by a much more gradual decline. More detailed examination indicated that the curve of retention was markedly influenced by many factors, particularly the method by which retention was measured. According to Davis and Moore, the recall method resulted in the measurement of the largest amount of retention, while recognition ranked second and relearning ranked third.

Sterrett and Davis (1954) reviewed a number of studies on the retention of school learning and noted in comparing studies that, although similar techniques and kinds of tests were used, the results were frequently conflicting. Their findings indicated the importance of knowing the composition of the group studied as well as the various conditions which affect the learning process.

Retention Studies with Preschool Children. Few retention studies have been done with preschool children. No doubt, this is due partially to the difficulty of finding materials and methods suitable for use with young children and partially to the fact that many preschool programs are based on the underlying theory that early childhood education should provide a broad experiential background for later learning. As a result, formal evaluation of learning, such as a retention study, is not only difficult, but is even considered irrelevant to the objectives of the preschool program.

Several learning and retention studies have been conducted with preschool children, however. Meek (1925) conducted a word-recognition study with seventy-one subjects, four to six years of age, and found that the arrangement of the amount of time between practice periods had an important effect on the amount children remembered and that, when intervals up to 14 days in length intervened between practice periods, in no case was there total forgetting of the material learned.

In a somewhat similar study with 180 preschool subjects, using block and picture associations as the learning material, Kirkwood (1926) found that presentation of material on alternate days resulted in greater economy of learning than did presentation on successive days. After a lapse of one year, children still evidenced some retention of the original learning.

Foster (1928) studied the verbal memory for stories of thirty-one children, two to four years of age. Children of higher chronological and mental ages showed superior ability in reproducing stories. Boys showed greater ability in this regard than did girls.

Mott and Martin (1947) investigated the retention of number concepts learned in kindergarten and found that, while the ability to count by rote to one hundred diminished over a three-month period, other abilities, such as object counting and the repetition of a series of numbers, showed a significant degree of retention over the same period.

In a single, longitudinal case study reported by Burtt (1932; 1937; 1941) tthe learning of Greek verse in early childhood, before the age of three years, facilitated relearning of the same material at the age of eight and a half years. Successive examinations of retention indicated a negligible influence of early learning on relearning at the age of fourteen and no influence at all upon relearning at the age of eighteen years.

Mallay (1935) studied the ability of preschool children to remember motor tasks--specifically, the movements necessary for opening specially prepared boxes. The memory span, or time of retention, was found to increase with chronological age and decrease with the greater complexity of the problem.

McGeoch (1935) conducted several studies of reminiscence, that is, the improvement of recall of incompletely learned material after an interval of time, without intervenient formal learning or review. A comparison of reminiscence in college students and preschool children over a twenty-four hour period showed that, although young children learned and recalled only half as much as college students, they were equal to the older subjects in relative retention.

Summary. A review of related research reveals that the relatively few studies involving haptic abilities, which have been conducted, have been carried on independently of each other. Several of these studies, however, have taken their inspiration from the work of Piaget. Furthermore, the review of research on the retention of learning indicates that very few attempts have been made to evaluate, by formal means, the retention of learning acquired in preschool classes.

Purpose of the Study

In the longitudinal assessment of subjects who participated in the Concannon experiment, the present investigation sought answers to several questions. Among these the following were considered to be of major interest.

1. How permanent is the acquired learning and how stable are the haptic abilities attained in a special program emphasizing haptic perception?
2. Over a period of time, do experimental and control subjects lose or gain in measures of haptic learning? How do their scores compare on the six and twelve months post-tests?
3. Do subjects from a Montessori type of preschool program, emphasizing enriched sensorial learning, remain superior in certain haptic abilities to subjects from more traditional preschool programs over relatively long periods of time?
4. After a lapse of six or twelve months, do any differences appear in the retention of learning and haptic abilities of subjects who received individual instruction and subjects who received group instruction in the original learning program?
5. Do the six and twelve months post-tests reveal sex differences in performance on the various haptic tests?
6. Do the six and twelve months post-tests show any differences attributable to the preschool session (morning or afternoon) attended?
7. Do mental age, chronological age, or years of schooling received prior to participation in the haptic experiment make any significant contribution to scores received on the follow-up tests?

Hypotheses

The following hypotheses were tested:

1. If pretest scores are controlled, when subjects who have participated in a program of learning experiences involving haptic perception are tested after a lapse of six and/or twelve months following completion of the program, there is no significant difference between

post-test means (for both six and twelve month intervals) in haptic perception scores

(a) of subjects in individual instruction and subjects in group instruction.

(b) of subjects who attended a modified-Montessori preschool program and subjects who attended a non-Montessori preschool program.

(c) of boys and girls.

(d) of subjects who attended a morning preschool session and subjects who attended an afternoon preschool session.

(e) of subjects who differ in chronological age.

(f) of subjects who differ in mental age.

(g) of subjects who differ in years of schooling received prior to participation in the haptic learning program.

2. When subjects who participated in a program of learning experiences involving haptic perception and subjects who composed the control group for this experiment are tested after a lapse of six and/or twelve months following completion of the program, differences in pre- and post-test means of the experimental group and differences in pre- and post-test means of the control group will not differ significantly when these are analyzed for the following factors:

(a) type of treatment received in the experimental program.

(b) type of instruction received in the program.

(c) type of preschool attended.

(d) sex

(e) session attended in the preschool program.

(f) chronological age.

(g) mental age.

(h) years of schooling received prior to participation in the experimental program.

CHAPTER II

METHOD

At the end of the Concannon experiment, administrators of the participating schools kindly consented to have examiners return to test subjects after a lapse of six months and again after a lapse of a total of twelve months. In all, four examiners were engaged in the follow-up testing.

Schools from which subjects were drawn are located in a wide range of socioeconomic areas in Boston and vicinity and were chosen ton constitute a representative sample of schools today. The schools taking part in the original experiment were:

1. Emmanuel House, located in a low income area, enrolls children of ages 3, 4, and 5 for a morning session only. The school is open to all children free of charge. About seventy-five per cent of the pupils are non-white.

2. The Labouré School, an all-day day-care center, is located in a predominantly lower-middle income area. There are no non-white families in the neighborhood.

3. The Chestnut Hill School, located in a suburban area, enrolls children from the upper economic levels. Children of ages 3, 4, and 5 attend a morning session and pay a fairly high rate of tuition.

4. St. Peter's School, an all day modified-Montessori school, is situated in an area of about the same economic level as the Labouré School. Children of ages 3, 4, and 5 attend either a morning or an afternoon session and pay a small tuition.

Design and Procedure

The Emmanuel House, Labouré, and Chestnut Hill Schools supplied the non-Montessori subjects. The six months post-test was administered to these subjects in December, 1965 and the twelve months post-test was administered to them in June, 1966. St. Peter's School supplied the Montessori subjects for the study. The six months post-test was administered to the Montessori subjects in May and June of 1966 and the twelve months post-test was administered in January, 1967.

By the time follow-up testing occurred, a number of subjects had left their original preschool classes and had enrolled in other schools. This was especially true of children who had passed from kindergarten to first grade. Where possible, arrangements were made for a team of examiners to administer the six and twelve months post-tests in each school where three or more subjects were in attendance. Individual appointments were made for all other subjects. In all, 91 per cent or 131 of the 144 subjects in the original experiment completed both the six and twelve months post-tests. Attrition, in almost every case where it occurred, was due to the fact that the family had moved too far away to permit the child to return for follow-up testing.

Figure 1 shows the number of subjects participating in the present study, arranged according to their placement in the schema of the Concannon experiment. Control subjects in the original experiment received only group instruction because it was considered highly unlikely that individual instruction in the neutral activities which constituted the control treatment could have an effect that would differ appreciably from that of group instruction.

Data and Instrumentation

For each subject, complete background information, as obtained for the Concannon experiment, was recorded on a master card. Mental age in months had been obtained for each subject from the administration of the Revised Stanford-Binet Test of Intelligence, Form L-M. Three personality measures which had been included in the Concannon experiment and which were found to have no significant interaction with gain scores, were omitted from any analysis in the follow-up study.

Equipment and Testing Procedure

To obtain the haptic test data, each subject was tested individually in a room apart from his regular classroom. Twenty plywood forms of geometric design, devised by Concannon, comprised the testing material. Forms were 3/8 inch thick and their maximum width or diameter was approximately 3 inches, so that each form could be grasped and handled with ease by a child. The subject was asked to put his hands through an opening in a small screen which enabled him to handle the objects presented to him but not to see them.

The five tests of haptic perception devised and used by Concannon as the pretest and post-test of the original experiment were repeated with each subject at the end of the six and twelve month intervals. A score of 1 was given for each correct answer

SCHOOL:		MONTESSORI				NON-MONTESSORI			
TREATMENT:		Experimental				Experimental			
SEX:		Boys		Girls		Boys		Girls	
INSTRUCTION:		Ind.	Gr.	Ind.	Gr.	Ind.	Gr.	Ind.	Gr.
SESSION:	a. m.	7	6	6	6	5	4	5	5
	p. m.	5	6	6	7	4	4	6	6

TREATMENT:		Control		Control	
SEX:		Boys	Girls	Boys	Girls
INSTRUCTION:		Group	Group	Group	Group
SESSION:	a. m.	7	5	5	6
	p. m.	6	5	5	4

Total Montessori Ss: 72 Total Non-Montessori Ss: 59

Figure 1. Placement of Subjects

and zero for each incorrect response. A perfect score for any one test was 20, and the total score possible on all tests was 100. A sample of the Test Data Card, used in scoring, appears in Appendix A.

In Test 1 the subject was handed each geometric form and asked to identify it or its constituent shapes by the geometric name(s).

In Test 2, two identical and one non-identical forms were handed to the subject, and he was asked to match the two identical forms. It is conceivable, especially when one considers Lowenfeld's (1945) thesis, that haptic perception in Test 2 would not necessarily involve the translation of tactile sensations into visual images, since the subject could detect similarities by placing two forms, one on top of the other, and turning and manipulating them until similar sides, angles, and/or opening were aligned.

Four 3 x 10 inch unglazed white cards, each containing black line drawings of five geometric shapes, were used in Test 3. As each geometric form was presented haptically to the child, he was shown a card and asked to point to the picture of the form he was handling. Test 3 thus asked the subject to visualize and identify a haptically perceived form in terms of a line drawing approximately one-half the size of the form it represented. Reproductions of the cards and drawings used in Test 3 appear in Appendix B.

Test 4 required the subject to draw a picture of the form he perceived haptically. A sheet of white paper, 8½ x 11 inches, divided into twenty blocks, was provided for this purpose. Scores on Test 4 were necessarily affected by the motor development of the subject. In the original experiment, after the instruction and practice afforded by the learning program, several subjects who attained high scores on the other four tests were unable to draw any form except the circle, and a few of these subjects produced similar records in the follow-up testing. A copy of the sheet provided for drawing appears in Appendix C.

In Test 5, the subject was asked to describe verbally the characteristics of the form he perceived haptically.

The five tests probed diverse, although positively correlated, aspects of haptic perception (Concannon, 1966). Answers to Tests 1 and 5 required verbalization, while Test 2, 3, and 4 required performance only. The original learning program had provided experimental subjects with numerous opportunities to learn and use the tactual and motor skills and the identifying and descriptive terms which were later examined in the final test of the original experiment and the present study.

The final test of the Concannon (1966) experiment constituted the pretest of the follow-up study. Independent variables for the study were: (1) type of treatment (experimental or control); (2) type of instruction (individual or group); (3) type of preschool attended (Montessori or non-Montessori); (4) sex; (5) session attended in the preschool program (morning or afternoon); (6) chronological age in months; (7) mental age in months from the Revised Stanford-Binet Intelligence Scale, Form L-M; and (8) years in school previous to participation in the Concannon experiment.

Dependent variables for the comparisons within the experimental group were scores from the six months and twelve months post-tests. Dependent variables for comparisons between experimental and control subjects were the differences between the pretest of the follow-up study and the six or twelve months post-test. In the original experiment, this type of difference score was called a "gain score," a term considered inappropriate in the follow-up study because many subjects, especially in the experimental group, showed a loss of one or more points on the six months or twelve months post-test. Since positive changes in pretest to post-test differences could reflect not only retention, but also natural development of haptic abilities, the term "retention score" was considered an equally unsuitable designation. For the purposes of the follow-up study, therefore, differences between pretest and post-test scores were named "change scores" because this term appeared more likely than other alternatives to convey the true nature of these dependent variables and to avoid misleading connotations.

On the advice of Dr. Robert A. Bottenberg, senior research consultant for the study, change scores from the six months to twelve months testing period were not included in the analysis and report because the differences involved were small and appeared more likely to obscure, rather than elucidate, the major objectives of the study.

Statistical Procedure

The general statistical approach to the analysis of the data was a multiple analysis of covariance. Pretest scores were used as covariates for the six and twelve months post-test scores. Change or growth in a specific aspect of haptic recognition was indicated by a change from pretest to post-test performance in that aspect of haptic recognition.

In the testing of Hypothesis 1, five scores for each of the two post-test periods made a total of ten scores which were used as the criterion measures in this part of the analysis. Each score was subjected to a separate covariance analysis. For each set of scores, four types of independent variables: instruction, school, sex, and session were considered as factors for which main effects were tested, with chronological age, mental age, years in school, and pretest scores taken as concomitant variables.

In the testing of Hypothesis 2, a similar procedure was followed. Five change scores, computed for each of the two post-test periods, made a total of ten change scores, and these were the criterion measures for the second part of the analysis. Each change score was subjected to a separate covariance analysis. For each set of change scores, five types of inedpendent variables: treatment, instruction, school, sex, and session were considered as factors for which main effects were tested, with chronological age, mental age, and years in school taken as concomitant variables.

The computational analysis of the criterion variables was based on vector concepts and multiple linear regression models described in Bottenberg and Ward's Applied Multiple Regression Analysis (1963). Tests on main effects and linear regressions were made in this procedure by computing error sums of squares for appropriate full and restricted multiple regression models. The error sum of squares (e. s. s.) for any regression model was obtained by computing the squared multiple correlation coefficient, R^2, for that regression model and obtaining the e. s. s. as

$$N \times (\text{criterion variance}) \times (1-R^2)$$

This computational approach permitted the use of existing intercorrelation and multiple correlation computer routines, and provided for the solution of a system of normal equations where orthogonality could not be maintained between independent factors. Orthogonality could not be maintained because, regardless of the distribution of subjects in the original experiment, attrition of subjects in the follow-up study resulted in an uneven distribution of N's in the various cells of the design.

An intercorrelation matrix containing all variables to be used in the analysis was obtained for the 131 cases in the study. With this as input a series of regression models was specified, and R^2 for each model was computed by using the appropriate set of input variables from the matrix. An identical set of regression problems was run and R^2s computed with respect to independent variables using the appropriate criterion (dependent) variables.

All statistical analyses on the research project were computer processed using Fortran programs with existing Fortran subroutines for intercorrelations, multiple correlations, data transformation, and F-ratio with corresponding probability level computation. Programs were prepared by Dr. Robert A. Bottenberg of Lackland Air Force Base, Texas, the senior research design consultant for the study.

CHAPTER III

RESULTS

In the Concannon (1966) experiment, subjects divided by type of school and type of experiment formed the experimental and control groups. Experimental subjects were assigned to either individual or group instruction. Control subjects received group instruction only, since individual instruction, in the neutral activities of the control treatment, was considered impractical and unlikely to have a significant influence on results. Within each school, stratified random assignment, by sex, session, and chronological age, placed subjects in experimental-individual, experimental-group, and control treatments.

Analysis of Data

Table 1 summarizes the major groupings of subjects who participated in the six and twelve months follow-up testing. Despite the attrition of thirteen subjects, major groups showed only slight and non-significant variations in mean mental age and chronological age, with three exceptions. Experimental non-Montessori subjects were older than Montessori subjects, and among subjects who received individual instruction, non-Montessori subjects were older than Montessori subjects. In the experimental group, the mean mental age of girls was higher than that of boys. All three of these differences were significant at the .05 level.

For the 88 subjects in the experimental group, the range in mental age was from 27 to 90 months, and in chronological age from 36 to 70 months. The 43 control subjects ranged in mental age from 32 to 96 months and in chronological age from 39 to 71 months.

Forty-three of the subjects in the experimental group had attended a morning preschool session during the Concannon experiment and 45 had attended an afternoon preschool session. Twenty-one control subjects had attended preschool in the morning, while 22 had attended afternoon sessions.

Three children had attended school for three years; 26 for two years; 41 for one year; and 61 were enrolled for the first time.

Mental age, chronological age, and years in school have been reported according to measurements recorded at the inauguration of the Concannon experiment.

TABLE 1

RESULTS OF t-TESTS BETWEEN MAJOR GROUPS FOR MENTAL AGES AND CHRONOLOGICAL AGES[a]

Group	N	Mental Age				Chronological Age			
		$\bar{X}$	σ	t	p	$\bar{X}$	σ	t	p
Total exp.	88	66.14	11.88			55.56	8.66		
Total cont.	43	63.40	12.15	1.22	>.05	56.51	7.73	.61	>.05
Exp. ind.	44	66.59	11.47			54.75	8.74		
Exp. group	44	65.68	12.27	.35	>.05	56.36	8.50	.87	>.05
Mont.	72	64.11	11.93			54.68	8.13		
N-Mont.	59	66.61	12.04	1.18	>.05	57.32	8.44	1.80	>.05
Exp. Mont.	49	65.29	12.12			53.88	8.49		
Exp. n-Mont.	39	67.21	11.49	.75	>.05	57.67	8.40	2.07	<.05
Exp. Mont.	49	65.29	12.12			53.88	8.49		
Cont. Mont.	23	61.61	11.10	1.22	>.05	56.39	7.00	1.22	>.05
Exp. n-Mont.	39	67.21	11.49			57.67	8.40		
Cont. n-Mont.	20	65.45	12.96	.52	>.05	56.65	8.49	.43	>.05
Exp. ind.									
Mont.	24	65.50	11.68			52.21	8.22		
N-Mont.	20	69.10	10.69	1.32	>.05	57.80	8.36	2.18	<.05
Exp. group									
Mont.	25	66.04	12.49			55.48	8.44		
N-Mont.	19	65.21	11.95	.22	>.05	57.53	8.44	.78	>.05
Exp. male	41	69.12	9.16			56.80	7.20		
Exp. female	47	63.53	13.29	2.24	<.05	54.47	9.62	1.26	>.05
Exp. a.m.	43	67.86	12.41			55.47	8.96		
Exp. p.m.	45	64.49	11.11	1.33	>.05	55.64	8.36	.10	>.05

[a] Data assembled from measurements of mental and chronological ages made at the beginning of the Concannon (1966) experiment.

The F-ratio (probability level = .05) tested the homogeneity of the variance among the means of the dependent variables.

Testing of Hypothesis 1. Hypothesis 1 dealt with differences between post-test means of groups receiving experimental treatment.

> Hypothesis 1.--If pretest scores are controlled, when children who have participated in a program of learning experiences involving haptic perception are tested after a lapse of six and/or twelve months following completion of the program, there is no significant difference between post-test means (for both six and twelve month intervals) in haptic perception scores.
>
> (a) of subjects in individual instruction and subjects in group instruction.
>
> (b) of subjects who attended a modified-Montessori preschool program and subjects who attended a non-Montessori preschool program.
>
> (c) of boys and girls.
>
> (d) of subjects who attended a morning preschool session and subjects who attended an afternoon preschool session.
>
> (e) of subjects who differ in chronological age.
>
> (f) of subjects who differ in mental age.
>
> (g) of subjects who differ in years of schooling received prior to participation in the haptic learning program.

In the analysis of data concerned with Hypothesis 1, chronological age, mental age, previous years in school, and pretest scores were held constant while tests of significance were made to indicate the effects of instruction, school, sex, and session on post-test means. Means appearing in the following tables were taken directly from haptic test data. In the statistical analysis, however, these means were adjusted by covariance. Occasionally in Tables 2 through 5, relatively large differences in post-test means are not accompanied by significant F-ratios. It should be remembered that this situation would result from the existence of large differences in the corresponding pretest means. Pretest and post-test means and standard deviations for subjects in experimental treatment are presented in Appendix D.

Hypothesis 1 (a): Individual vs. group instruction.--Table 2 presents the analysis of data for subjects in individual and group instruction. The only F-ratio that was significant appeared on Test 4 of the six months post-test. This was significant at the .01 level and favored subjects who had received group instruction. Subjects in individual and in group instruction did not differ significantly on the final test of the Concannon experiment.

According to the evidence presented in Table 2, Hypothesis 1(a) was supported by all but one F-ratio.

TABLE 2

ANALYSIS OF COVARIANCE FOR POST-TEST MEANS OF EXPERIMENTAL SUBJECTS IN INDIVIDUAL AND GROUP INSTRUCTION

Interval	Test	Post-test Means				F	P
		Individual (N = 44)		Group (N = 44)			
		$\bar{X}$	σ	$\bar{X}$	σ		
Six months	1	15.20	3.89	14.61	5.08	.36	>.05
	2	15.39	3.27	15.25	3.14	.00	>.05
	3	16.43	2.59	16.14	2.64	.18	>.05
	4	11.16	4.91	12.16	4.73	7.60	<.01
	5	15.59	3.55	15.27	4.74	.03	>.05
Twelve months	1	15.36	3.60	14.86	4.08	.19	>.05
	2	16.00	3.02	16.68	2.89	1.43	>.05
	3	16.73	2.82	16.61	2.68	.13	>.05
	4	13.36	4.64	13.11	4.35	.21	>.05
	5	16.52	2.86	16.14	3.65	.02	>.05

Hypothesis 1 (b): Montessori vs. non-Montessori Preschool Classes.--Data from Montessori and non-Montessori subjects in experimental treatment are presented in Table 3. On the six months post-test the only significant F-ratio favored non-Montessori subjects on Test 4. Two differences, significant at the .01 and .05 levels, occurred at the twelve months interval. These favored the Montessori subjects on Tests 2 and 3, respectively. In the final test of Concannon's experiment, Montessori subjects excelled non-Montessori subjects by differences significant at the .05 level on Tests 1, 3 and 5.

TABLE 3

ANALYSIS OF COVARIANCE FOR POST-TEST MEANS OF MONTESSORI AND NON-MONTESSORI SUBJECTS IN EXPERIMENTAL TREATMENT

Interval	Test	Post-test Means				F	P
		Montessori (N = 49)		Non-Montessori (N = 39)			
		$\bar{X}$	σ	$\bar{X}$	σ		
Six months	1	16.37	3.60	13.08	4.91	3.09	$>.05$
	2	15.55	3.31	15.03	3.05	.00	$>.05$
	3	16.33	2.67	16.23	2.56	.01	$>.05$
	4	11.31	4.89	12.10	4.76	6.62	$<.05$
	5	16.80	3.28	13.72	4.57	1.76	$>.05$
Twelve months	1	15.31	3.70	14.87	4.03	1.34	$>.05$
	2	17.14	2.54	15.33	3.16	7.23	$<.01$
	3	17.37	1.79	15.79	3.42	4.35	$<.05$
	4	13.24	4.17	13.23	4.88	1.46	$>.05$
	5	16.29	2.74	16.38	3.87	2.70	$>.05$

Hypothesis 1(b) was confirmed by all but one test for the six months interval and by three tests for the twelve months interval. Empirical evidence, therefore, tended to support, but did not fully confirm Hypothesis 1(b).

No significant differences appear in Table E-1 of Appendix E which compares Montessori and non-Montessori subjects in individual instruction. In Table E-2, which presents data for

Montessori and non-Montessori subjects in group instruction, a difference significant at the .01 level appeared in Test 4 of the six months post-test and favored the non-Montessori subjects. On the twelve months post-test, Montessori subjects excelled non-Montessori subjects on Test 2 by a difference significant at the .01 level.

Hypothesis 1(c): Boys vs. girls.--Six and twelve months post-test scores revealed no significant differences between the performance of boys and girls. Hypothesis 1(c) was accepted on the basis of the information recorded in Table 4.

TABLE 4

ANALYSIS OF COVARIANCE FOR POST-TEST MEANS OF MALE AND FEMALE SUBJECTS IN EXPERIMENTAL TREATMENT

Interval	Test	Post-test Means				F	P
		Male (N = 41)		Female (N = 47)			
		$\bar{X}$	σ	$\bar{X}$	σ		
Six months	1	15.24	4.11	14.62	4.86	1.31	>.05
	2	15.39	3.21	15.26	3.21	.50	>.05
	3	16.12	2.88	16.43	2.36	2.30	>.05
	4	12.10	4.42	11.28	5.17	.69	>.05
	5	15.93	3.62	15.00	4.59	.14	>.05
Twelve months	1	15.61	3.24	14.68	4.28	.00	>.05
	2	16.51	2.54	16.19	3.30	.28	>.05
	3	17.44	2.05	16.00	3.09	2.69	>.05
	4	13.54	3.68	12.98	5.09	.99	>.05
	5	16.80	2.51	15.91	3.79	.00	>.05

When data for male and female subjects were analyzed according to type of instruction received, a few differences appeared. All of these were significant at the .01 level, and all favored girls who had received individual instruction. Table E-3 in Appendix E summarizes this information, while the data in Table E-4 indicates that no significant differences appeared in the analysis of post-test scores for boys and girls who had received group instruction.

Hypothesis 1(d): Morning session vs. afternoon session. --As shown in Table 5, subjects from morning and afternoon preschool sessions performed equally well on the six months post-test. Differences, significant at the .05 level, favored morning session subjects on two tests of the twelve months post-test. Hypothesis 1(d) was confirmed for the six months post-test, but was not fully confirmed for the twelve months interval.

Table E-5 in Appendix E shows only one significant difference favoring subjects who received individual instruction in morning preschool sessions. Among subjects who received group instruction, however, Table E-6 shows three differences, all significant at the .05 level, and all favoring the morning session. These occurred on Tests 1 and 4 of the six months post-test, and the difference on Test 1 persisted on the twelve months post-test.

Hypothesis 1(e), 1(f), and 1(g). Hypotheses 1(e), 1(f), and 1(g) were tested by determining the significance of the contribution made by the independent variable to the dependent variables when other factors were held constant.

Hypothesis 1(e): Chronological age.--Results for the independent contribution of chronological age to post-test scores are recorded in Table 6. No significant F-ratios occurred on the six months post-test, but two differences, significant at the .05 level, appeared on Tests 3 and 5 at the twelve months interval. Hypothesis 1(e) was confirmed for the six months interval, but could not be fully accepted for the twelve months interval.

Hypothesis 1(f): Mental age.--Analysis of the independent contribution of mental age to post-test scores is summarized in Table 7. On the six months post-test two F-ratios, significant at the .01 and .001 levels, occurred on Tests 1 and 4, respectively. On the twelve months post-test, the only significant F-ratio appeared on Test 4. The information contained in Table 7 tends to support Hypothesis 1(f) for all haptic tests except those which involve the drawing of haptically perceived forms.

TABLE 5

ANALYSIS OF COVARIANCE FOR POST-TEST MEANS OF EXPERIMENTAL SUBJECTS IN MORNING AND AFTERNOON PRESCHOOL SESSIONS

Interval	Test	Post-test Means				F	P
		Morning (N = 43)		Afternoon (N = 45)			
		$\bar{X}$	σ	$\bar{X}$	σ		
Six months	1	15.72	3.29	14.13	5.36	1.99	>.05
	2	15.63	3.10	15.02	3.28	.61	>.05
	3	16.37	2.44	16.20	2.78	.00	>.05
	4	11.49	4.82	11.82	4.87	.90	>.05
	5	15.91	2.96	14.98	5.05	.96	>.05
Twelve months	1	16.09	2.65	14.18	4.54	4.49	<.05
	2	16.28	2.81	16.40	3.12	.19	>.05
	3	17.30	2.38	16.07	2.95	4.81	<.05
	4	13.26	4.33	13.22	4.65	.02	>.05
	5	16.84	2.54	15.84	3.81	1.64	>.05

Hypothesis 1(g): Years of Schooling.--Years of schooling received prior to participation in the Concannon experiment made no significant contribution to post-test scores for six and twelve months intervals. Table 8 presents the evidence for the acceptance of Hypothesis 1(g).

TABLE 6

TESTS FOR THE INDEPENDENT CONTRIBUTION OF CHRONOLOGICAL AGE TO POST-TEST SCORES

Test	Six Months Post-test		Twelve Months Post-test	
	F	p	F	p
1	1.23	>.05	1.83	>.05
2	.88	>.05	1.23	>.05
3	.02	>.05	3.98	<.05
4	.43	>.05	.04	>.05
5	1.78	>.05	4.21	<.05

TABLE 7

TESTS FOR THE INDEPENDENT CONTRIBUTION OF MENTAL AGE TO POST-TEST SCORES

Test	Six Months Post-test		Twelve Months Post-test	
	F	p	F	p
1	9.35	<.01	3.01	>.05
2	1.54	>.05	3.86	>.05
3	3.04	>.05	.86	>.05
4	11.79	<.001	4.01	<.05
5	2.08	>.05	2.05	>.05

TABLE 8

TESTS FOR THE INDEPENDENT CONTRIBUTION OF PREVIOUS YEARS IN SCHOOL TO POST-TEST SCORES

Test	Six Months Post-test		Twelve Months Post-test	
	F	p	F	p
1	1.16	>.05	2.96	>.05
2	.25	>.05	.07	>.05
3	.33	>.05	.03	>.05
4	1.55	>.05	1.29	>.05
5	0.00	>.05	.58	>.05

Findings regarding Hypothesis 1 may be summarized thus:

1. Subjects who had received individual instruction and subjects who had received group instruction were approximately equal in performance on both post-tests.

2. No significant differences appeared between mean scores of subjects from Montessori preschool classes and subjects from non-Montessori preschool classes on four tests of the six months post-test. Non-Montessori subjects had significantly higher scores on Test 4 of that post-test. On the twelve months post-test, Montessori subjects excelled non-Montessori subjects by significant differences on two of the five haptic tests.

3. Boys and girls were approximately equal on all six and twelve months post-test scores.

4. For the six months interval, no significant differences appeared between subjects from a morning and subjects from an afternoon preschool session. On the twelve months post-test two significant differences appeared, both favoring the morning session.

5. Chronological age had very little effect on post-test scores. Significance was attained in only one test at the twelve months interval.

6. The contribution of mental age to post-test scores was negligible on most of the haptic tests. However, mental

age made a significant contribution to scores on Test 4 at both the six and the twelve months intervals. Test 4 required the drawing of haptically perceived forms. A significant F-ratio also appeared on Test 1 of the six months post-test.

7. Years of schooling received prior to participation in the Concannon experiment made no significant contribution to post-test scores.

Testing of Hypothesis 2. Hypothesis 2 dealt with comparisons of subjects in experimental treatment and subjects in control treatment. The dependent variables concerned were the change scores, that is, the differences between pretest and post-test scores for the six months and twelve months intervals. Change score means appearing in the following tables were taken directly from haptic test data. In the statistical analysis, these means were adjusted by covariance. Where significant differences occur, it should be noted that, while adjusted means would vary somewhat from the means presented in the table, the differences between adjusted means was in the same direction as is indicated by the tabular data.

Hypothesis 2.-- When subjects who participated in a program of learning experience involving haptic perception and subjects who composed the control group for this experiment are tested after a lapse of six and/or twelve months following completion of the program, differences in pre- and post-test scores in the experimental group and differences in pre- and post-test scores in the control group will not differ significantly when these differences are analyzed for the following factors:

(a) type of treatment received in the experimental program.

(b) type of instruction received in the program.

(c) type of preschool attended.

(d) sex.

(e) session attended in the preschool program.

(f) chronological age.

(g) mental age.

(h) years of schooling received prior to participation in the experimental program.

Hypothesis 2(a): Type of treatment.--Table 9 summarizes pretest and post-test scores and standard deviations for experimental and control subjects. In every test the experimental group surpassed the control group in mean score.

TABLE 9

MEANS AND STANDARD DEVIATIONS OF PRETEST AND POST-TEST SCORES FOR SUBJECTS IN EXPERIMENTAL AND CONTROL TREATMENTS

Test	Pretest		Six months Post-test		Twelve months Post-test	
	$\bar{X}$	σ	$\bar{X}$	σ	$\bar{X}$	σ
Experimental (N = 88)						
1	17.97	2.47	14.91	4.54	15.11	3.86
2	17.26	2.98	15.32	3.21	16.34	2.97
3	18.24	1.81	16.28	2.62	16.67	2.75
4	13.64	5.48	11.66	4.85	13.24	4.50
5	17.86	3.14	15.43	4.19	16.33	3.29
Control (N = 43)						
1	10.23	5.70	9.88	4.87	12.21	4.27
2	13.70	5.30	13.19	3.58	15.14	2.90
3	13.51	5.46	13.65	3.96	15.16	2.99
4	5.70	4.41	7.67	4.81	10.79	4.55
5	9.26	5.16	10.12	4.76	13.40	4.13

The analysis of covariance for change scores appears in Table 10. In every test, the control group showed a smaller loss or a higher gain than did the experimental group. All differences were significant, most of them at the .001 level. Therefore, Hypothesis 2(a) was rejected.

TABLE 10

ANALYSIS OF COVARIANCE FOR MEAN CHANGE SCORES OF SUBJECTS IN EXPERIMENTAL AND CONTROL TREATMENTS

Interval	Test	Mean Change Score				F	p
		Experimental (N = 88)		Control (N = 43)			
		$\overline{X}$	σ	$\overline{X}$	σ		
Six months	1	-3.06[a]	3.41	-0.35	3.80	20.64	<.001
	2	-1.94	3.55	-0.51	4.36	4.25	<.05
	3	-1.95	2.65	0.14	4.35	13.20	<.001
	4	-1.98	3.06	1.98	3.20	45.07	<.001
	5	-2.43	3.08	0.86	3.17	28.87	<.001
Twelve months	1	-2.85	3.43	1.98	4.23	47.73	<.001
	2	-0.92	3.07	1.44	5.24	10.12	<.01
	3	-1.57	2.65	1.65	4.58	23.30	<.001
	4	-0.40	2.90	5.09	3.76	86.24	<.001
	5	-1.53	3.10	4.14	3.89	74.58	<.001

[a] Minus sign indicates a loss between the pretest and post-test of the follow-up study. The final test of the Concannon experiment was the pretest of the follow-up study.

On the final test of Concannon's experiment, experimental subjects received significantly higher gain scores than did the control subjects on four of the five haptic tests.

Pretest and post-test scores and standard deviations for experimental and control subjects, divided by type of preschool attended, are presented in Table F-1 of Appendix F. In both the Montessori and non-Montessori groups, experimental subjects excelled controls on every test.

Table 11 summarizes change scores data for Montessori subjects. At the six months interval, one difference between change scores was significant at the .01 level and two were significant at the .001 level. All differences favored the control group. On the twelve months post-test, all differences were significant, three at the .001 level and one each at the .01 and .05 levels. These differences, too, favored the control group. Similar results occurred with non-Montessori subjects, as shown in Table 12. The only non-significant difference appeared on Test 2 in both the six and the twelve months post-tests.

Pretest and post-test scores and standard deviations for boys and girls in experimental and control treatments are shown in Table F-2 of Appendix F. On every test boys and girls in the experimental group received higher mean scores than boys and girls in the control group.

All F-ratios for the change scores for boys summarized in Table 13 were significant and favored the control group. Table 14 shows that results were somewhat less decisive for girls. On the six months post-test, only two differences were significant. These were at the .001 level and favored the control group. Results from the twelve months post-test showed only one non-significant difference which appeared on Test 2. On the other four tests, control girls were superior to experimental girls in change score means.

Table F-3 in Appendix F summarizes pretest and post-test means and standard deviations for experimental and control subjects divided according to attendance in a morning or an afternoon preschool session. Experimental subjects were superior to controls on the mean score of every test.

The analysis of covariance for change scores of subjects from a morning preschool session is presented in Table 15. In all tests except one, for the six months interval, control subjects received significantly higher change scores than experimental subjects. Among subjects from an afternoon session, for both the six and twelve months intervals, control subjects were significantly superior to experimental subjects in four out of the five haptic tests. On both post-tests a non-significant difference appeared for Test 2. This information is summarized in Table 16.

TABLE 11

ANALYSIS OF COVARIANCE FOR MEAN CHANGE SCORES OF MONTESSORI SUBJECTS IN EXPERIMENTAL AND CONTROL TREATMENTS

Interval	Test	Mean Change Score				F	p
		Experimental (N = 49)		Control (N = 23)			
		$\bar{X}$	σ	$\bar{X}$	σ		
Six months	1	-2.39[a]	2.90	0.04	3.62	8.53	<.01
	2	-2.22	3.48	-0.78	3.55	2.32	>.05
	3	-2.51	2.66	-1.52	3.85	1.84	>.05
	4	-2.65	2.87	2.78	2.37	51.52	<.001
	5	-2.41	2.95	1.43	3.42	19.49	<.001
Twelve months	1	-3.45	3.30	2.13	4.71	34.19	<.001
	2	-0.63	3.23	2.30	5.25	8.66	<.01
	3	-1.47	2.33	1.04	5.40	6.53	<.05
	4	-0.71	3.00	6.30	3.28	82.96	<.001
	5	-2.92	2.35	4.04	3.42	63.86	<.001

[a] Minus sign indicates a loss between the pretest and post-test of the follow-up study. The final test of the Concannon experiment was the pretest of the follow-up study.

TABLE 12

ANALYSIS OF COVARIANCE FOR MEAN CHANGE SCORES OF NON-MONTESSORI SUBJECTS IN EXPERIMENTAL AND CONTROL TREATMENTS

Interval	Test	Mean Change Score				F	p
		Experimental (N = 39)		Control (N = 20)			
		$\bar{X}$	σ	$\bar{X}$	σ		
Six months	1	-3.90[a]	3.79	-0.80	3.94	11.24	<.01
	2	-1.59	3.60	-0.20	5.11	1.37	>.05
	3	-1.26	2.46	2.05	4.10	13.39	<.001
	4	-1.13	3.09	1.05	3.73	7.48	<.01
	5	-2.46	3.24	0.20	2.69	9.40	<.01
Twelve months	1	-2.10	3.44	1.80	3.59	14.61	<.001
	2	-1.28	2.82	0.45	5.03	2.13	>.05
	3	-1.69	3.01	2.35	3.28	17.01	<.001
	4	-0.00	2.72	3.70	3.80	19.06	<.001
	5	0.21	3.05	4.25	4.37	20.71	<.001

[a] Minus sign indicates a loss between the pretest and posttest of the follow-up study. The final test of the Concannon experiment was the pretest of the follow-up study.

TABLE 13

ANALYSIS OF COVARIANCE FOR MEAN CHANGE SCORES OF MALE SUBJECTS IN EXPERIMENTAL AND CONTROL TREATMENTS

Interval	Test	Mean Change Score				F	p
		Experimental (N = 41)		Control (N = 23)			
		$\bar{X}$	σ	$\bar{X}$	σ		
Six months	1	-3.15[a]	3.21	0.52	3.40	22.19	<.001
	2	-2.20	3.43	0.39	5.16	5.71	<.05
	3	-2.46	2.88	1.26	4.95	19.75	<.001
	4	-2.22	3.45	1.26	2.57	17.31	<.001
	5	-2.46	3.11	0.65	2.90	13.38	<.001
Twelve months	1	-2.78	3.00	2.57	3.84	30.02	<.001
	2	-1.07	3.29	2.30	5.77	9.65	<.01
	3	-1.15	2.46	2.87	5.14	17.65	<.001
	4	-0.78	3.10	5.13	4.19	44.50	<.001
	5	-1.59	3.00	3.70	3.11	32.35	<.001

[a] Minus sign indicates a loss between the pretest and post-test of the follow-up study. The final test of the Concannon experiment was the pretest of the follow-up study.

TABLE 14

ANALYSIS OF COVARIANCE FOR MEAN CHANGE SCORES OF FEMALE SUBJECTS IN EXPERIMENTAL AND CONTROL TREATMENTS

Interval	Test	Mean Change Score				F	p
		Experimental (N = 47)		Control (N = 20)			
		$\bar{X}$	σ	$\bar{X}$	σ		
Six months	1	-2.98[a]	3.56	-1.35	3.98	2.66	$>.05$
	2	-1.72	3.63	-1.55	2.87	.09	$>.05$
	3	-1.51	2.33	-1.15	3.09	.33	$>.05$
	4	-1.77	2.67	2.80	3.63	30.59	$<.001$
	5	-2.40	3.06	1.10	3.43	14.59	$<.001$
Twelve months	1	-2.91	3.76	1.30	4.54	17.40	$<.001$
	2	-0.79	2.86	.45	4.34	1.73	$>.05$
	3	-1.94	2.76	.25	3.33	5.87	$<.05$
	4	-0.06	2.67	5.05	3.19	40.38	$<.001$
	5	-1.49	3.19	4.65	4.57	44.74	$<.001$

[a] Minus sign indicates a loss between pretest and posttest of the follow-up study. The final test of the Concannon experiment was the pretest of the follow-up study.

TABLE 15

ANALYSIS OF COVARIANCE FOR MEAN CHANGE SCORES OF SUBJECTS FROM MORNING PRESCHOOL SESSIONS IN EXPERIMENTAL AND CONTROL TREATMENTS

Interval	Test	Mean Change Score				F	p
		Experimental (N = 43)		Control (N = 21)			
		$\bar{X}$	σ	$\bar{X}$	σ		
Six months	1	-2.49[a]	2.63	0.05	3.90	9.46	<.01
	2	-1.58	3.15	0.48	4.02	3.70	>.05
	3	-1.88	2.70	0.33	4.90	5.93	<.05
	4	-2.09	3.23	2.81	2.52	36.78	<.001
	5	-2.09	2.84	0.90	2.60	11.60	<.001
Twelve months	1	-2.12	2.76	2.90	4.66	24.84	<.001
	2	-0.93	3.14	2.48	5.84	10.59	<.01
	3	-0.95	2.62	2.81	4.80	14.58	<.001
	4	-0.33	2.71	5.67	3.54	51.96	<.001
	5	-1.16	3.33	4.71	4.45	38.62	<.001

[a] Minus sign indicates a loss between pretest and posttest of the follow-up study. The final test of the Concannon experiment was the pretest of the follow-up study.

TABLE 16

ANALYSIS OF COVARIANCE FOR MEAN CHANGE SCORES OF SUBJECTS FROM AN AFTERNOON PRESCHOOL SESSION IN EXPERIMENTAL AND CONTROL TREATMENTS

Interval	Test	Mean Change Score				F	p
		Experimental (N = 45)		Control (N = 22)			
		$\bar{X}$	σ	$\bar{X}$	σ		
Six months	1	-3.60[a]	3.94	-0.73	3.66	10.59	$<.01$
	2	-2.29	3.86	-1.45	4.46	0.69	$>.05$
	3	-2.02	2.59	-0.05	3.75	6.41	$<.05$
	4	-1.87	2.90	1.18	3.56	14.83	$<.001$
	5	-2.76	3.26	0.82	3.63	17.30	$<.001$
Twelve months	1	-3.56	3.83	1.09	3.55	22.81	$<.001$
	2	-0.91	3.00	0.45	4.37	1.65	$>.05$
	3	-2.16	2.55	0.55	4.08	8.39	$<.01$
	4	-0.47	3.07	4.55	3.88	36.68	$<.001$
	5	1.89	2.81	3.59	3.17	39.45	$<.001$

[a] Minus sign indicates a loss between pretest and posttest of the follow-up study. The final test of the Concannon experiment was the pretest of the follow-up study.

Hypothesis 2(b): Type of instruction.--Table 17 summarizes the analysis of covariance for experimental subjects in individual and group instruction. The only significant difference was at the .05 level and appeared on Test 4 of the six months post-test. This favored group-instructed subjects, who also excelled individually-instructed subjects by a significant difference in mean scores on the same test at the six months interval, as shown in Table 2. Both individually and group-instructed subjects showed losses in change scores on every test for both intervals. On the basis of the information appearing in Table 17, Hypothesis 2(b) was accepted for the six months interval and for all but one test at the twelve months interval.

Control subjects received only group instruction. Their change score data, therefore, could not be analyzed for differences in type of instruction received.

Concannon (1966) found no significant differences in gain scores of subjects who received individual instruction and those who received group instruction.

Hypothesis 2(c): Type of preschool.--The analysis of covariance for change scores of Montessori and non-Montessori subjects in experimental treatment is presented in Table 18. Four significant differences appeared, all favoring non-Montessori subjects. At the six months interval, a difference on Test 4 was significant at the .01 level. At the twelve months interval, differences significant at the .05 level appeared on Tests 1 and 4, while a difference at the .001 level of significance appeared on Test 5. Non-Montessori subjects gained in change scores on Test 5 at the twelve months interval. Otherwise both Montessori and non-Montessori experimental subjects experienced losses in change scores on all tests for both intervals.

In the analysis of covariance for post-test means of Montessori and non-Montessori subjects in experimental treatment, which appears in Table 3, Test 4 at the six months interval showed a significant difference favoring non-Montessori subjects, while Tests 2 and 3 at the twelve months interval showed significant differences at the .01 and .05 levels, respectively, favoring Montessori subjects.

The analysis of covariance for change scores of control subjects from Montessori and non-Montessori preschool classes appears in Table 19. A single significant difference appeared on Test 3 at the six months interval. This was at the .05 level and favored non-Montessori subjects. On the six months post-test the two control groups gained in change scores on some tests and lost in change scores on others. The twelve months post-test, however, showed change score gains on all tests for both control groups.

TABLE 17

ANALYSIS OF COVARIANCE FOR MEAN CHANGE SCORES OF EXPERIMENTAL SUBJECTS IN INDIVIDUAL AND GROUP INSTRUCTION

Interval	Test	Mean Change Score				F	p
		Individual (N = 44)		Group (N = 44)			
		$\bar{X}$	σ	$\bar{X}$	σ		
Six months	1	-2.93[a]	2.81	-3.18	3.91	.03	>.05
	2	-2.23	3.79	-1.66	3.26	.72	>.05
	3	-1.86	2.94	-2.05	2.31	.07	>.05
	4	-2.82	2.29	-1.14	3.48	11.24	<.01
	5	-2.73	2.73	-2.14	3.37	.71	>.05
Twelve months	1	-2.77	3.20	-2.93	3.63	.00	>.05
	2	-1.61	3.14	-0.23	2.84	3.11	>.05
	3	-1.57	2.83	-1.57	2.46	.01	>.05
	4	-0.61	2.56	-0.18	3.19	1.33	>.05
	5	-1.80	2.77	-1.27	3.38	.76	>.05

[a] Minus sign indicates a loss between pretest and post-test of the follow-up study. The final test of the Concannon experiment was the pretest of the follow-up study.

TABLE 18

ANALYSIS OF COVARIANCE FOR MEAN CHANGE SCORES OF EXPERIMENTAL SUBJECTS FROM MONTESSORI AND NON-MONTESSORI PRESCHOOL CLASSES

Interval	Test	Mean Change Score				F	p
		Montessori (N = 49)		Non-Montessori (N = 39)			
		$\bar{X}$	σ	$\bar{X}$	σ		
Six months	1	-2.39[a]	2.90	-3.90	3.79	.18	$>.05$
	2	-2.22	3.48	-1.59	3.60	.73	$>.05$
	3	-2.51	2.66	-1.26	2.46	.34	$>.05$
	4	-2.65	2.87	-1.13	3.09	10.85	$<.01$
	5	-2.41	2.95	-2.46	3.24	.06	$>.05$
Twelve months	1	-3.45	3.30	-2.10	3.44	6.60	$<.05$
	2	-0.63	3.23	-1.28	2.82	.57	$>.05$
	3	-1.47	2.33	-1.69	3.01	.33	$>.05$
	4	-0.71	3.00	-0.00	2.72	5.53	$<.05$
	5	-2.92	2.35	0.21	3.05	14.67	$<.001$

Minus sign indicates a loss between pretest and posttest of the follow-up study. The final test of the Concannon experiment was the pretest of the follow-up study.

TABLE 19

ANALYSIS OF COVARIANCE FOR MEAN CHANGE SCORES OF CONTROL SUBJECTS FROM MONTESSORI AND NON-MONTESSORI PRESCHOOL CLASSES

Interval	Test	Mean Change Score				F	p
		Montessori (N = 23)		Non-Montessori (N = 20)			
		$\bar{X}$	σ	$\bar{X}$	σ		
Six months	1	.04	3.62	-0.80	3.94	.01	>.05
	2	-0.78[a]	3.55	-0.20	5.11	.20	>.05
	3	-1.52	3.85	2.05	4.10	4.36	<.05
	4	2.78	2.38	1.05	3.73	.13	>.05
	5	1.43	3.42	0.20	2.69	.39	>.05
Twelve months	1	2.13	4.71	1.80	3.59	.54	>.05
	2	2.30	5.25	0.45	5.03	2.36	>.05
	3	1.04	5.40	2.35	3.28	.52	>.05
	4	6.30	3.28	3.70	3.80	1.53	>.05
	5	4.04	3.42	4.25	4.37	.60	>.05

[a] Minus sign indicates a loss between pretest and posttest of the follow-up study. The final test of the Concannon experiment was the pretest of the follow-up study.

With regard to experimental subjects, the information appearing in Table 18 indicates that Hypothesis 2(c) was supported by four out of five tests at the six months interval, but by only two of the five tests at the twelve months interval. With regard to control subjects and the data appearing in Table 19, Hypothesis 2(c) was supported by all but one test at the six months interval and by all tests at the twelve months interval. Empirical evidence, therefore, tended toward rejection of Hypothesis 2(c) for experimental subjects and toward acceptance of Hypothesis 2(c) for control groups.

In her comparisons of gain scores for Montessori and non-Montessori subjects, Concannon (1966) found differences significant at the .001 level on every test and all of these favored Montessori subjects.

Hypothesis 2(d): Sex.--In Table 20 the analysis of covariance for mean change scores of male and female subjects in experimental treatment revealed two significant differences on the six months post-test and no significant differences on the twelve months post-test. On Tests 1 and 3 at the six months interval, girls excelled boys by differences significant at the .05 and .01 levels, respectively. In the analysis of covariance summarized in Table 4, however, boys and girls in experimental treatment did not differ significantly in mean scores on any test at either interval.

The analysis of covariance for mean change scores of male and female subjects in control treatment is presented in Table 21. At both intervals a difference significant at the .05 level appeared on Test 3 and favored control boys.

Among experimental subjects, boys and girls lost in change scores on every test at both intervals. In contrast, control boys gained in change scores on every test of both post-tests. Control girls lost in change scores on Tests 1, 2, and 3 of the six months post-test, but gained in change scores on Tests 4 and 5 at that interval and on all tests at the twelve months interval.

While not completely decisive in either case, empirical evidence tended to confirm Hypothesis 2(d) for both experimental and control subjects.

In her experiment Concannon (1966) found significant differences in gain scores favoring girls on Tests 1, 2, and 3, and a significant difference favoring boys on Test 4.

TABLE 20

ANALYSIS OF COVARIANCE FOR MEAN CHANGE SCORES OF MALE AND FEMALE SUBJECTS IN EXPERIMENTAL TREATMENT

Interval	Test	Mean Change Score				F	p
		Male (N = 41)		Female (N = 47)			
		$\bar{X}$	σ	$\bar{X}$	σ		
Six months	1	-3.15[a]	3.21	-2.98	3.56	4.51	$<.05$
	2	-2.20	3.43	-1.72	3.63	1.94	$>.05$
	3	-2.46	2.88	-1.51	2.33	7.35	$<.01$
	4	-2.22	3.45	-1.77	2.67	1.31	$>.05$
	5	-2.46	3.11	-2.40	3.06	.01	$>.05$
Twelve months	1	-2.78	3.00	-2.91	3.76	.67	$>.05$
	2	-1.07	3.29	-0.79	2.86	1.33	$>.05$
	3	-1.15	2.46	-1.94	2.76	1.29	$>.05$
	4	-0.78	3.10	-0.06	2.67	.01	$>.05$
	5	-1.59	3.00	-1.49	3.19	.64	$>.05$

[a] Minus sign indicates a loss between pretest and posttest of the follow-up study. The final test of the Concannon experiment was the pretest of the follow-up study.

TABLE 21

ANALYSIS OF COVARIANCE FOR MEAN CHANGE SCORES OF MALE AND FEMALE SUBJECTS IN CONTROL TREATMENT

Interval	Test	Mean Change Score				F	p
		Male (N = 23)		Female (N = 20)			
		$\bar{X}$	σ	$\bar{X}$	σ		
Six months	1	.52	3.40	-1.35[a]	3.98	3.57	>.05
	2	.39	5.16	-1.55	2.87	1.92	>.05
	3	1.26	4.95	-1.15	3.09	6.24	<.05
	4	1.26	2.57	2.80	3.63	3.82	>.05
	5	.65	2.90	1.10	3.43	.13	>.05
Twelve months	1	2.57	3.84	1.30	4.54	1.04	>.05
	2	2.30	5.77	.45	4.34	1.50	>.05
	3	2.87	5.14	.25	3.33	5.63	<.05
	4	5.13	4.19	5.05	3.19	.28	>.05
	5	3.70	3.11	4.65	4.57	.79	>.05

[a] Minus sign indicates a loss between pretest and posttest of the follow-up study. The final test of the Concannon experiment was the pretest of the follow-up study.

Hypothesis 2(e): Sessions.--Table 22 contains the analysis of covariance for mean change scores of experimental subjects from morning and afternoon preschool sessions. Both groups showed losses in change scores on every test at both intervals; however no significant differences appeared on either post-test.

TABLE 22

ANALYSIS OF COVARIANCE FOR MEAN CHANGE SCORES OF EXPERIMENTAL SUBJECTS FROM MORNING AND AFTERNOON PRESCHOOL SESSIONS

Interval	Test	Mean Change Score				F	p
		Morning (N = 43)		Afternoon (N = 45)			
		$\bar{X}$	σ	$\bar{X}$	σ		
Six months	1	-2.49[a]	2.63	-3.60	3.94	.04	>.05
	2	-1.58	3.15	-2.29	3.86	.55	>.05
	3	-1.88	2.70	-2.02	2.59	.03	>.05
	4	-2.09	3.23	-1.87	2.90	3.22	>.05
	5	-2.09	2.84	-2.76	3.26	.18	>.05
Twelve months	1	-2.12	2.76	-3.56	3.83	.04	>.05
	2	-0.93	3.14	-0.91	3.00	1.97	>.05
	3	-0.95	2.62	-2.16	2.55	.41	>.05
	4	-0.33	2.71	-0.47	3.07	.98	>.05
	5	-1.16	3.33	-1.89	2.81	.02	>.05

[a] Minus sign indicates a loss between pretest and post-test of the follow-up study. The final test of the Concannon experiment was the pretest of the follow-up study.

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In the analysis of covariance for mean scores of experimental subjects from morning and afternoon preschool sessions which appears in Table 5, there were no significant differences on the six months post-test. Two differences significant at the .05 level appeared on the twelve months post-test and these favored the morning group.

The analysis of covariance for mean change scores of control subjects from morning and afternoon preschool sessions is presented in Table 23. There were no significant differences at the six months interval, but a singel difference, significant at the .05 level and favoring subjects from morning sessions, appeared on the twelve months post-test. Control subjects from morning preschool sessions showed increases in change scores on every test at both intervals. Control subjects from afternoon preschool sessions lost in change scores on three tests of the six months post-test but gained in change scores on all other tests at both intervals.

Concannon (1966) found no significant differences between subjects from morning and subjects from afternoon preschool sessions.

Hypotheses 2(f), 2(g), and 2(h). Hypotheses 2(f), 2(g), and 2(h) were tested by determining the significance of the contribution made by the independent variables to the dependent variables, the change scores, when other factors were held constant.

Hypothesis 2(f). Chronological age.--Table 24 summarizes the tests for the independent contribution of chronological age to change scores. No significant F-ratios appeared on the six months post-test and only one significant F-ratio appeared on the twelve months post-test. Empirical evidence favored acceptance of Hypothesis 2(f).

In her experiment Concannon (1966) found that increments in chronological age had a significant effect on gain scores for three of the five haptic tests.

Hypothesis 2(g): Mental age.--The summary of tests for the independent contribution of mental age to change scores is summarized in Table 25. The only significant F-ratio was at the .05 level and occurred on Test 1 for the six months interval. These findings tended to confirm Hypothesis 2(g).

Increments in mental age had no significant effect on gain scores in the Concannon (1966) experiment.

TABLE 23

ANALYSIS OF COVARIANCE FOR MEAN CHANGE SCORES OF CONTROL SUBJECTS FROM MORNING AND AFTERNOON PRESCHOOL SESSIONS

Interval	Test	Mean Change Score				F	p
		Morning (N = 21)		Afternoon (N = 22)			
		$\bar{X}$	σ	$\bar{X}$	σ		
Six months	1	.05	3.90	-0.73[a]	3.66	.29	$>.05$
	2	.48	4.02	-1.45	4.46	2.15	$>.05$
	3	.33	4.90	-0.05	3.75	.00	$>.05$
	4	2.81	2.52	1.18	3.56	3.29	$>.05$
	5	.90	2.60	.82	3.63	.02	$>.05$
Twelve months	1	2.90	4.66	1.09	3.55	1.94	$>.05$
	2	2.48	5.84	.45	4.37	2.88	$>.05$
	3	2.81	4.80	.55	4.08	4.26	$<.05$
	4	5.67	3.54	4.55	3.88	1.65	$>.05$
	5	4.71	4.45	3.59	3.17	1.06	$>.05$

[a] Minus sign indicates a loss between pretest and posttest of the follow-up study. The final test of the Concannon experiment was the pretest of the follow-up study.

TABLE 24

TESTS FOR THE INDEPENDENT CONTRIBUTION OF CHRONOLOGICAL AGE TO CHANGE SCORES

Test	Six Months Post-test		Twelve Months Post-test	
	F	p	F	p
1	.04	>.05	.01	>.05
2	.35	>.05	.54	>.05
3	.46	>.05	.39	>.05
4	1.48	>.05	4.03	<.05
5	.81	>.05	.56	>.05

TABLE 25

TESTS FOR THE INDEPENDENT CONTRIBUTION OF MENTAL AGE TO CHANGE SCORES

Test	Six Months Post-test		Twelve Months Post-test	
	F	p	F	p
1	5.06	<.05	.70	>.05
2	.01	>.05	.00	>.05
3	.00	>.05	1.93	>.05
4	1.79	>.05	.47	>.05
5	.04	>.05	.85	>.05

Hypothesis 2(h): Years in school.--Table 26 presents the results of tests for the independent contribution of years in school prior to participation in the Concannon experiment. Only one significant F-ratio appeared and this was on Test 4 of the six months post-test. Empirical evidence, while not absolutely decisive, favored acceptance of Hypothesis 2(h).

Previous years in school had no appreciable effect on gain scores in the Concannon experiment.

TABLE 26

TESTS FOR THE INDEPENDENT CONTRIBUTION OF PREVIOUS YEARS IN SCHOOL TO CHANGE SCORES

Test	Six Months Post-test		Twelve Months Post-test	
	F	p	F	p
1	2.43	>.05	3.25	>.05
2	.07	>.05	.22	>.05
3	1.34	>.05	.27	>.05
4	4.34	<.05	2.76	>.05
5	.37	>.05	.89	>.05

Findings with regard to Hypothesis 2 may be summarized as follows.

1. While experimental subjects surpassed controls on all pretest and post-test means, control subjects attained significantly higher change scores for both the six and twelve months intervals.

2. When subjects were divided according to type of preschool attended, sex, and preschool session attended, comparisons between experimental and control subjects had the following results:

(a) Montessori and non-Montessori experimental subjects excelled Montessori and non-Montessori control subjects, respectively, in all mean scores of the six and twelve months post-tests. Among both Montessori and non-Montessori subjects, controls obtained significantly higher change scores on a majority of the haptic tests at both the six and the twelve months intervals.

(b) Boys and girls in the experimental group were superior to boys and girls in the control group on post-test means for every test at the six and twelve months intervals. Control boys were significantly higher than experimental boys in change scores for both six and twelve months post-tests. While experimental and control girls did not differ significantly in change scores on three of the five haptic tests at the six months interval, control girls attained significantly higher change scores for four of the five haptic tests in the twelve months post-test.

(c) When subjects were divided according to the preschool session attended, in each session subjects in experimental treatment surpassed controls in post-test means. Among subjects from a morning preschool session, controls received significantly higher change scores on all but one of the haptic tests for the six months interval and on all haptic tests for the twelve months interval. Among subjects from an afternoon preschool session, controls obtained significantly higher change scores on four of the five tests for each interval.

3. There was very little difference between change scores attained at the six months and twelve months intervals by experimental subjects who had received individual instruction and those who had received group instruction.

4. Among experimental subjects from Montessori and non-Montessori preschool classes, only one significant difference in change scores occurred on the six months post-test. This favored non-Montessori subjects who also surpassed Montessori subjects by significant differences in change scores on three of the five haptic tests at the twelve months interval.

5. Among control subjects from Montessori and non-Montessori preschool classes, there was very little difference in change scores attained at either interval.

6. In a comparison of change scores for boys and girls in experimental treatment, girls were significantly superior to boys on two tests of the six months post-test, but there were no significant differences between boys and girls at the twelve months interval.

7. Only slight differences appeared in change scores attained by boys and girls in control treatment. A significant difference favoring boys occurred on Test 3 at both the six and the twelve months intervals.

8. Within the experimental group, analysis of change scores revealed no significant differences between subjects from morning and subjects from afternoon preschool sessions.

9. Among control subjects, differences in change scores between subjects from morning and subjects from afternoon preschool classes were slight and virtually negligible.

10. Chronological age made little contribution to haptic change scores. The only significant F-ratio appeared on the twelve months post-test.

11. Mental age made little contribution to haptic change scores. One significant F-ratio appeared on the six months post-test.

12. Years of schooling received prior to participation in the Concannon (1966) experiment had little effect on change scores. Only one significant F-ratio appeared on the six months post-test.

Comparisons with Concannon's Results

In several instances results from the follow-up study were in agreement with Concannon's findings. Among subjects in experimental treatment, those who had received individual instruction and those who had received group instruction did not differ appreciably on either mean scores or gain scores on the final test of the Concannon (1966) experiment. Group-instructed subjects were significantly higher in mean score and in change scores on Test 4 of the six months post-test, but otherwise no significant differences appeared between the two groups at either interval of the follow-up study. In the Concannon experiment, subjects from morning and afternoon preschool sessions did not differ significantly in gain scores on any haptic test. This was further substantiated in the follow-up study. The only significant difference in change scores which appeared favored subjects in control treatment who had attended morning preschool sessions.

Concannon found that mental age and previous years of schooling had no effect on gain scores. In the follow-up study these factors made only slight, and perhaps negligible contributions to change scores. In each case a single significant F-ratio appeared on the six months post-test.

Elsewhere, some contrasts to Concannon's findings appeared. Montessori subjects, who were significantly superior in mean scores to non-Montessori subjects on Tests 1, 3, and 5 in the final test of Concannon's experiment, were significantly lower than non-Montessori subjects on Test 4 of the six months post-test. Differences in mean scores between the two groups on other tests of the six months post-test were non-significant; however, Montessori subjects excelled non-Montessori subjects in mean scores on Tests 2 and 3 of the twelve months post-test. Montessori subjects received significantly higher gain scores than did non-Montessori subjects on all five haptic tests in Concannon's experiment. Among experimental subjects in the follow-up study, non-Montessori subjects excelled Montessori by significant differences in change scores on one test at the six months interval and three tests at the twelve months interval, while Montessori subjects were not favored by any significant differences in change scores. Only one significant difference occurred among control subjects. This was on the six months post-test and favored non-Montessori subjects.

Experimental subjects received significantly higher gain scores than control subjects on four of the five haptic tests at the end of the Concannon experiment. In the follow-up study, this trend was reversed and control subjects received significantly higher change scores on all tests for both the six and the twelve months intervals. This type of reversal was not unexpected, however, because the post-tests measured both haptic abilities and the retention of learning, a matter which will receive further discussion in Chapter IV.

In gain score measurements made at the end of the Concannon's experiment, girls excelled boys by significant differences on three haptic tests, while boys excelled girls on one test. Among boys and girls who had received experimental treatment, only two significant differences occurred in the follow-up study. Both were at the six months interval and both favored girls. Among control subjects, again only two significant differences appeared, one at each interval and both favoring control boys.

In Concannon's experiment, increments in chronological age had a significant effect on gain scores in three of the haptic tests. In the follow-up study, chronological age made no significant contribution to change scores on the six months post-test and made a significant contribution to change scores on only one test at the twelve months interval.

CHAPTER IV

DISCUSSION

Performance on the six months and twelve months post-tests reflected both the natural development of haptic abilities and the retention of learning. Experimental treatment in Concannon's experiment involved the recognition and association or memorization of identifying cues detected through haptic perception. This type of learning activity is probably more in keeping with the sensory training practices of a Montessori preschool program than with practices in more traditional preschool classes. Experimental treatment also involved visual study of geometric forms, the acquisition and practical application of terminology, such as "circle," "triangle," "side," etc., and the description and drawing of visually as well as haptically perceived forms. These activities resemble learning experiences encountered in both Montessori and non-Montessori learning situations.

In projecting findings from the research reported here to other preschool children or other preschool programs and activities, caution must be exercised, first of all, because the use of haptic learning material was, in itself, rather unique. Secondly, every study is necessarily limited by the number of subjects comprising its sample. While subjects participating in the study came from socioeconomic levels ranging from the lower-lower to the upper classes and were in many ways representative of urban and suburban preschool populations, the total sample consisted of 131 subjects and was, therefore, only a small percentage of the children then enrolled in preschool programs throughout the United States. Nevertheless, since the learning experiences involved were similar in many ways to current preschool activities and since subjects who participated resembled many other preschool children, findings from the follow-up study offer some useful information regarding preschool education and may help point out questions that can be studied profitably in further research.

Analysis of post-test means and change scores of experimental subjects afforded a more complete picture of retention and haptic development than would have been available from the analysis of either type of score alone. Post-test means presented the level of toal performance that had been attained during the six months and the year following completion of

Concannon's experiment. Change scores demonstrated differences between pretest (i.e. final test of the Concannon experiment) and post-test performance and indicated whether post-test performance represented a loss from, or a gain over, pretest scores. In the follow-up study post-test means and change score means were subjected to appropriate adjustments by covariance. Since post-test scores were measures of total performance and change scores were measures of differences between pre- and post-test performances, significant differences and F-ratios which appeared in the analysis of post-test means were not always--and were , in fact, seldom--predictive of significant findings for the same groups and tests in the analysis of change scores. Conversely, significant findings in the analysis of change scores seldom coincided with significant findings in the analysis of post-test means.

In cases where a single significant F-ratio occurred in the five haptic tests comprising a post-test, it should be remembered that, even in a series of tests where, theoretically, there were no real differences, five per cent of the test analyses would be expected to show significance at the .05 level on the basis of chance alone. Thus it is possible that an isolated F-ratio, significant at the .05 level, is of less importance than it immediately appears.

Experimental vs. Control Treatments: Loss and Gain in Change Scores

A preliminary examination of findings from the follow-up study reveals what is, perhaps, its most striking contrast to Concannon's results in Tables 10 through 16. Here comparisons of change scores, i. e., differences between pretest and post-tests scores, for experimental and control subjects showed a reversal of the trend found by Concannon. At completion of the latter's experiment, experimental subjects were decidely superior to control subjects in gain scores, i. e., the differences between scores on the initial and final tests of the experiment, on four of the five haptic tests.

At both the six and twelve months intervals of the follow-up study, experimental subjects excelled controls in mean scores, but controls obtained significantly higher change scores than did subjects who had received experimental treatment. When data was further analyzed according to type of preschool attended, sex, and preschool session attended, all significant differences favored subjects from the control group. Considering the abilities and learning examined in the post-tests, however, these results were not unexpected. Subjects who had not participated in a program of planned learning activities continued to progress in haptic abilities and to acquire related learning, since opportunities to learn terms as, for instance, geometric names for forms, and relationships, such as "inside," "outside," and "touching," are available outside formal learning situations. Participation in the experiment treatment of the haptic learning program had enabled most of the experimental subjects to acquire proficiency in the exercise of haptic abilities and in the use of a vocabulary somewhat more technical and specific than that ordinarily used by preschool children for the identification and description of geometric forms. Usually a retention study shows some loss in this type of proficiency.

Comparisons of change scores for experimental and control subjects from a Montessori preschool program showed that control subjects surpassed experimental subjects by significant differences on all but two tests, Tests 2 and 3 at the six months interval. In a similar comparison of subjects from non-Montessori preschool programs, controls surpassed experimentals by significant differences on all tests except Test 2 at both intervals. Apparently a common background in the sensory experiences provided by the Montessori system did not cause the relationship between change scores for Montessori experimental and control subjects to vary from the general relationship which appeared between change scores for non-Montessori subjects from experimental and control treatments.

In the follow-up study, there were instances in which control subjects experienced losses in change scores. These losses were slight and in only two instances did they involve significant differences between comparative control groups.

Type of Instruction Received

Analysis of post-test means and change score means of subjects in experimental treatment indicated that individual and group instruction were equally effective when evaluated by measurements made six months and twelve months after completion of the Concannon experiment. Apparently highly individualized instruction, such as that which characterizes the Montessori system of education, is not superior to group instruction in realizing the aims of a preschool learning situation. In both the analysis of post-test means and the analysis of change score means a single significant differences occurred. In each case this was at the .05 level on Test 4 of the six months post-test and favored group-instructed subjects. While this evidence indicated that, at the six months interval, group-instructed subjects were superior to individually-instructed subjects in the drawing of haptically perceived forms, in the overall performance differences between the two groups were considered slight and perhaps negligible.

While individual instruction provides a one-to-one relationship in which the pupil enjoys the undivided attention of the teacher, supposedly a minimum of distraction, and immediate reinforcement of appropriate responses or immediate correction of inappropriate responses, apparently group instruction also has its advantages. The group situation may provide more variety in the models of appropriate behavior which can be observed and imitated by the pupil, as well as motivation in the form of competition or participation with peers which is absent when individual instruction is used. In the Concannon experiment, group-instructed subjects probably observed a greater variety in the manner of exploring and matching haptic forms and in producing acceptable drawing and verbal responses than did individually instructed subjects. Furthermore, in a group, reinforcement of appropriate responses and correction of inappropriate responses can benefit not only the child whose work or behavior is being examined by the teacher, but also the other children present who, by group membership, have the opportunity to observe the situation and relate its implications to their own performance.

Although nothing in the present study substantiates the hypothesis, possibly the presence of peers in the learning situation provides a feeling of security and an absence of anxiety which do not obtain when the child works alone with the teacher and attempts to produce acceptable responses with a minimum of trial-and-error and delay. Perhaps these or other more subtle aspects of the learning situation help to equalize the efficiency of individual and group learning situations. Perhaps, too, educators at times place undue emphasis on the merits of either individual or group instruction, since even in the Montessori program, the child, after receiving instruction, works alone on the task to be mastered, practicing the skill involved or otherwise consolidating the learning acquired. Usually the child who has received group instruction also proceeds to similar practice of the appropriate skill or exercise of the newly acquired concepts. Presuming then that the pupil has sufficient motivation, maturation, and past experience to profit from the instruction given, he can acquire and retain learning equally well in either individual or group learning situations. Since, for most children and for most schools, individual instruction is a financial and practical impossibility, the question that should receive attention would seem to be: what size group will combine optimum learning conditions for the child with the economic use of personnel, space, time, and materials?

Type of Preschool Attended

In the analysis of covariance for post-test means of experimental subjects, dichotomized by type of preschool attended, non-Montessori subjects were significantly superior to Montessori subjects on Test 4 of the six months post-test, but Montessori subjects excelled by significantly higher scores on Tests 2 and 3 of the twelve months post-test. Significant differences in haptic test means favoring Montessori subjects had appeared on Tests 1, 3, and 5 of Concannon's final test. In Concannon's experiment, also, Montessori subjects excelled non-Montessori subjects by significant differences in gain scores on every test of the final test. In the Analysis of change scores for experimental subjects in the follow-up study, a difference significant at the .01 level and favoring non-Montessori subjects appeared on Test 4 at the six months interval. At the twelve months interval, differences significant at the .05 level appeared on Tests 1 and 4 while a difference significant at the .001 level appeared on Test 5. All three differences favored non-Montessori subjects. Among control subjects the only significant difference in change scores which appeared was at the .05 level. This was on Test 3 of the six months post-test and favored non-Montessori subjects.

This evidence indicated that Montessori subjects, who were superior to non-Montessori subjects at the end of the Concannon experiment, tended to lose that advantage in the course of time. The appearance of significant differences in post-test means, favoring Montessori subjects, on Tests 2 and 3 at the twelve months interval provided some evidence that the previous superiority of Montessori subjects had not disappeared completely in the year following Concannon's final test. Change score differences, favoring non-Montessori subjects indicated that, in the course of one year's time, the latter tended to lose less of their previously acquired learning and skill in the use of haptic abilities than did Montessori subjects. Results of the follow-up study led to the conclusion that, when evaluated on the basis of relatively long-term retention of specific learning, Montessori and non-Montessori preschool programs did not show marked differences in their effects.

A question suggested by these results is this: did superiority which Montessori subjects enjoyed over non-Montessori subjects, near and immediately following completion of Concannon's experiment, enable Montessori subjects, at the same time, to enjoy advantages in other types of learning beyond the scope of the haptic tests? Such a question might suggest further and broader investigations of the comparative effects of Montessori and traditional preschool programs.

It is also interesting to note that, although to an observer the knowledge and skills examined in Concannon's tests of haptic abilities would appear more in keeping with practices in sensory perception advocated by Montessori and less characteristic of non-Montessori preschool programs, Montessori and non-Montessori control subjects were approximately equal in change scores at both intervals of the follow-up study. Although, by virtue of their preschool backgroud, Montessori subjects might be expected to show greater improvement during this period in the learning and skills emphasized in Concannon's experiment, this was not the case.

Sex Differences

On the final test of her experiment, Concannon found that girls excelled boys by significant differences in gain scores on Tests 1, 2, and 3, while boys excelled girls by significant differences in gain scores on Test 4. In the follow-up study, no significant differences appeared between the post-test means of boys and girls on either the six or twelve months post-tests. Among experimental subjects only two significant differences in change scores occurred. These were on Tests 1 and 3 at the six months interval and favored girls. Among control subjects significant differences in change scores, favoring boys, appeared on Test 3 at both intervals. These findings led to the conclusion that sex differences in haptic learning measurements which appeared in Concannon's experiment tended to diminish and disappear within a year's time.

Session Attended

Concannon found no significant differences in gain scores when subjects were divided according to session (morning or afternoon) attended in a preschool program. In the analysis of post-test means no significant differences occurred at the six months interval, but two differences, significant at the .05 level and favoring experimental subjects from a morning session, appeared on Tests 1 and 3 at the twelve months interval. In the analysis of change scores no significant differences occurred among experimental subjects, while, among control sibjects, a single difference significant at the .05 level and favoring morning attenders appeared on Test 3 of the twelve months post-test.

While these findings might offer some slight encouragement to the position that the morning is the best time of day for learning, taken altogether, results from the follow-up study offer little evidence that the preschool session attended had more than a slight, and perhaps even negligible, effect upon haptic abilities and the retention of learning. Therefore, in schools where preschool children may attend either a morning or an afternoon session, it appears that attendance at either session should result in approximately the same acquisition and retention of learning.

Chronological Age

In her experiment Concannon found that chronological age had a significant effect on gain scores on Tests 2, 3, and 4. In the follow-up study chronological age made a significant contribution to change scores on only one test. This was significant at the .05 level and appeared on Test 4 of the twelve months post-test. Tests for the contribution of chronological age to post-test scores revealed two significant F-ratios on Tests 3 and 5 at the twelve months interval. These were at the .05 level of significance. Results, then, indicated that the relationship between chronological age and haptic test performance decreased with the passage of time.

Possibly haptic perception, as distinguished from skill in the manifestation and use of haptic perception, was the critical factor here. Since haptic perception is expected to increase with age and to reach its maximum development within the individual sometime between the ages of five and eight years--and often by the age of six--one would expect the relationship between haptic perception and chronological age to diminish as children approach and pass the age of six years. At the completion of Concannon's experiment 66 subjects were five years old or older, while 53 subjects were between the ages of four and five years. Therefore, at the completion of the follow-up study, 66 subjects were six years old or older, and a total of 119 subjects had passed the age of five years.

Lack of relationship between chronological age and six months scores may have indicated that a number of subjects had attained maximum or near-maximum development of haptic perception during this period. In this case the appearance of significant relationships between chronological age and twelve months scores would be ascribed primarily to retention and relearning of knowledge and skills acquired in the Concannon experiment. There is also the possibility, however, that lack of relationship between chronological age and six months scores may have resulted from a loss in acquired learning which was large enough to obscure the effect of increased development in haptic perception during this period. If this were the case, the relationship between chronological age and twelve months scores could be ascribed to the combined effect of the natural development of haptic perception and the retention or relearning of previously acquired skills. Commonplace experiences, in an out of school, could have provided subjects with opportunities to learn or relearn, in an informal way, knowledge which would contribute to performance on the haptic tests.

The single significant relationship between chronological age and change scores for Test 4 at the twelve months interval may have been of little consequence, or it may have indicated that, with increasing chronological age, subjects attained increased maturation of fine muscles and increased motor control and were able, therefore, to draw haptically perceived forms with greater success.

Mental Age

In her experiment Concannon found no relationship between mental age and haptic test performance. In the follow-up study, mental age was found to make significant contributions to post-test scores on two tests at the six months interval. One of these was at the .01 level of significance and appeared on Test 1, while the other was at the .001 level of significance and occurred on Test 4. On the twelve months post-test mental age made a contribution, significant at the .05 level, to post-test scores on Test 4. The only significant contribution made by mental age to change scores was at the .05 level and appeared on Test 1 of the six months post-test.

Test 1 required the use of geometric names to identify haptically perceived forms. Apparently, by the end of Concannon's experiment, subjects of various mental ages had attained approximately the same proficiency in applying stimulus names to haptically perceived forms. Follow-up findings indicated, however, that subjects of higher mental ages retained more of this type of specific learning during the six months following Concannon's final test than did younger subjects.

In the follow-up study mental age made significant contributions to scores on Test 4 of both post-tests. At the time of Concannon's experiment, lack of development in motor ability impeded the performance of many subjects on Test 4, which required the drawing of haptically perceived forms. This condition might account for the failure of a relationship to appear between mental age and scores on Test 4 un Concannon's experiment. Aside from its contribution to scores on Test 4, mental age had only slight, and perhaps negligible, influence on haptic test performance in the follow-up study.

Years in School

Concannon found that years of schooling received prior to participation in the haptic learning experiment had no relationship to gain scores on the haptic tests. In the follow-up study, previous years in school made no contribution to post-test scores and made a significant contribution to change scores on only one haptic test. This was at the .05 level and appeared on Test 4 st the six months interval. Evidence from the follow-up study, therefore, leads to the conclusion that previous years of schooling had only a negligible effect upon haptic test performance. In this regard, results of the follow-up study confirmed Concannon's findings. Apparently the number of years spent in a preschool program prior to participation in Concannon's experiment had little or no effect on the acquisition and retention of learning and haptic abilities.

Summary

In summary, the follow-up study revealed that, while experimental subjects received higher post-test means than did control subjects, control subjects excelled experimentals by significant differences in change scores. Apparently this resulted from the loss by experimental subjects of some of the proficiency in the exercise of haptic abilities and in the use of a relatively technical and specific vocabulary to identify and describe geometric forms which they had acquired during the Concannon experiment. Control subjects, on the other hand, had continued to progress in the natural development of haptic abilities and to acquire related learning, such as the names of geometric forms, since opportunities to learn these and similar terms are not confined to formal learning situations.

Individual and group instruction which had proved equally effective for learning in the Concannon experiment, were still equally effective when evaluated by tests administered six months and twelve months after the completion of the experiment.

Montessori subjects who had excelled non-Montessori subjects at the end of Concannon's experiment, tended to lose their advantage with the passage of time.

Sex differences in measurements of haptic abilities, which were found at the end of Concannon's experiment, tended to diminish and disappear in the course of a year.

Evidence from the follow-up study indicated that preschool session attended had little effect on haptic abilities and the retention of learning. These results were in keeping with Concannon's findings.

The relationship between chronological age and haptic test performance, which appeared in Concannon's experiment, decreased in the follow-up study.

Mental age, which had shown no relationship to haptic learning in Concannon's experiment, made a significant contribution to post-test scores on Test 4 at both intervals. Test 4 required the drawing of haptically perceived forms. Otherwise, the contribution of mental age to haptic test performance was slight and perhaps negligible.

Years of schooling received prior to participation in Concannon's experiment made very little contribution to change scores at either interval of the follow-up study. This evidence added further confirmation to results obtained in Concannon's experiment.

CHAPTER V

CONCLUSIONS, IMPLICATIONS, AND RECOMMENDATIONS

Conclusions and Implications

Of fundamental importance among the results of the follow-up study was recognition of the fact that preschool children retained a considerable amount of the learning they had acquired in a specific program of planned activities. Retention was demonstrated six months and a year after Concannon's experiment had ended. When speaking of the preschool period as a time of great learning, therefore, one should remember that this designation applies not only to a range of diffuse experiences which afford preparation and background for future learning, but also to specific learning which, when it is appropriately presented, can be acquired and retained over a relatively long period of time.

Results also suggest that the acquisition and retention of various types of learning in the preschool program might be subjected to formal evaluation as a means of determining the efficacy of methods used and the possibilities for improvements in learning conditions.

In the period studied, subjects from experimental treatment tended to lose in score, while control subjects tended to gain in score, or, in a few instances, lose less than did experimental subjects. Apparently experimental subjects lost some of the learning and skill in the use of haptic abilities which they had acquired during Concannon's experiment. Losses of this type are characteristic of a retention study and may even have masked some natrual development of haptic perception during the six months and twelve months intervals. At the same time, control subjects probably experienced some natural development in haptic abilities and acquired some related learning, such as the names of geometric forms, since opportunities to acquire this kind of information are available outside formal learning situations. Accessibility of such information may also have given experimental subjects opportunities to relearn, in an informal way, some of the material they had learned in Concannon's experiment and had subsequently forgotten. Relearning has often been used in the evaluation of retention. Presumably, subjects who had previously learned and forgotten material would master that material more quickly when it was presented to them a second time than would subjects who were exposed to the material for the first time.

Findings from the follow-up study indicated that individual and group instruction were equally effective when evaluated by measures made six and twelve months after completion of Concannon's experiment. A preschool program in which group instruction predominates, therefore, may offer opportunities for learning and retention that are equal to those presented in a program which stresses individual instruction.

Montessori subjects, who had been significantly superior to non-Montessori subjects in haptic test performance at the end of Concannon's experiment, tended to lose their advantage in the course of time. Within the experimental group several significant differences in change scores favored non-Montessori subjects. These results indicate that, when evaluated in terms of their long-term effects on specific learning, Montessori and non-Montessori preschool programs do not differ markedly. There is a possibility, however, that their earlier, although transient, superiority enabled Montessori to acquire other learning not subject to examination in the haptic tests.

Significant differences in change scores favored non-Montessori subjects and indicated that they had retained or relearned more of the knowledge and abilities examined by the haptic tests than had Montessori subjects. Montessori subjects, then, evidenced greater learning followed by less retention, while non-Montessori subjects demonstrated comparatively less learning followed by greater retention. Further investigation would be necessary to determine whether there are factors in the highly structured learning atmosphere of the Montessori program which encourage pupils to acquire a maximum amount of learning, but do not encourage a corresponding maximum of retention.

In Concannon's experiment girls excelled boys by significant differences in change scores on three haptic tests, while boys excelled girls by a significant difference in change scores on the test which required the drawing of haptically perceived forms. In the follow-up study, these differences tended to diminish and disappear and were, therefore, of presumably limited duration.

Concannon found no relationship between preschool session attended and haptic test performance. The few significant differences which appeared in the follow-up study demonstrated only slight and perhaps negligible superiority on the part of subjects who had attended a morning preschool session. Apparently attendance at either preschool session resulted in approximately the same retention of learning and haptic abilities.

Findings from the follow-up study indicated that the significant relationships between chronological age and haptic test performance, found in Concannon's experiment, tended to decrease in the course of time. Several factors could have contributed to these results. By the end of the follow-up period a number of subjects were approaching or had passed the age of six years, and many of these subjects may have attained their maximum or near-maximum development of haptic perception. If such were the case, chronological age would have made a progressively smaller contribution to haptic test performance. Significant relationships between chronological age and test scores appeared only at the twelve months interval in the follow-up study. The failure of chronological age to evidence any contribution to performance on the six months post-test might be attributed to the possibility that losses in retention masked any increased development in haptic perception which may have occurred during that period. Twelve months scores, then, could have evidenced the combined effects of retention, relearning, and natural development of haptic abilities.

In her experiment, Concannon found no relationship between mental age and haptic test performance. In the follow-up study, mental age made significant contributions to post-test scores and change scores on Test 1 at the six months interval and to post-test scores on Test 4 at both intervals. These findings indicate that, in Concannon's experiment, subjects of various mental ages attained approximately the same proficiency in naming haptically perceived forms, but subjects of higher mental ages retained more of this learning during the following six months. Apparently, however, this relationship was transient and of relatively minor importance, since it did not appear at the twelve months interval. Of greater importance was the fact that subjects of higher mental ages tended to receive higher scores on Test 4 at both intervals. Test 4 required the drawing of haptically perceived forms. Failure of Concannon's experiment to reveal a significant relationship between mental age and the drawing of haptically perceived forms may have been due to underdeveloped motor control which was found in subjects of various mental ages at that time and impeded their performance on Test 4.

Years of schooling received prior to participation in Concannon's experiment made only a negligible contribution to scores attained on the post-tests. Results of the follow-up study, therefore, confirmed Concannon's findings regarding this factor. Previous years of schooling did not have an appreciable effect on the retention of learning or haptic abilities. Apparently, the important factors which should be considered when providing for the child's early education are his ability to profit by preschool experiences and the benefits which the preschool program offers for him.

Recommendations

While recent enthusiasm for preschool education has recognized the ages of three to five years as an important time for learning, few attempts have been made to evaluate learning materials and methods at the preschool level by means of retention studies. The research reported here indicates that young children can acquire and retain a considerable amount of specific learning when it is presented to them in an appropriately designed program. Presumably, therefore retention studies should be as helpful in the examination and improvement of curricula and methods at the preschool level as they are at higher levels of education.

Since in both Concannon's experiment and in the follow-up study, individual and group instruction proved equally effective, further studies might concentrate on ascertaining the size of the group which facilitates optimum learning at the preschool level. Perhaps, too, some effort could be made to determine whether individual and group instruction result in essentially the same learning situation, or whether each type of instruction has its own distinctive characteristics which influence learning. Should the latter be the case, a way might be found to incorporate positive characteristics of individual instruction into the group situation, thus making group instruction even more effective in preschool education.

Montessori subjects, who were superior to non-Montessori subjects in haptic test performance at the end of Concannon's experiment, tended to lose their superiority in the course of time. Possibly, however, earlier superiority in one type of learning facilitated the acquisition of other types of learning not examined by the haptic tests. If some future research could be designed to examine the related effects of a specific learning program, results might produce a more comprehensive picture of the influence of Montessori and traditional preschool programs on the learning of young children.

Another point of comparison between Montessori and non-Montessori subjects offering possibilities for further investigation was the significant superiority in change scores which non-Montessori subjects achieved on the post-tests. Apparently, during the follow-up period, non-Montessori subjects retained or relearned more of their previously acquired learning than did Montessori subjects. Future investigations might attempt to validate these findings and to determine whether exposure to the highly structured learning atmosphere of the Montessori program encourages superiority in the acquisition of learning without encouraging comparable superiority in the retention of that learning.

In the follow-up study haptic test performance represented both the retention of acquired learning and the natural development of haptic perception. The separate effects of each factor could not be determined, since, as part of a learning experiment, Concannon's experimental treatment had been designed to include instruction and practice in the learning and skills required for successful performance on all of the haptic tests. Results from the follow-up study suggest that haptic tests which do not require verbalization or drawing are more likely, than tests which do require these abilities, to measure haptic perception with a minimum--although not an absence--of compounding effects from acquired learning, verbal ability, and motor control. While the relationships of haptic perception to chronological age and mental age are of interest to students of cognitive development, these relationships have not, as yet, been subjected to thorough investigation in a study designed to produce statistical verification of findings. Research on these relationships might use the haptic forms designed by Concannon in a series of non-verbal tests which do not require drawing.

CHAPTER VI

SUMMARY

A follow-up study was conducted to assess the retention of learning and the development of haptic perception in 131 of the 144 preschool subjects who had participated in Concannon's haptic learning experiment (Concannon, 1966). By haptic perception is meant the ability to identify objects by the sense of touch alone in the absence of visual stimulation (Piaget and Inhelder, 1956). The final test of Concannon's experiment which was used as the pretest and the post-tests of the follow-up study, was administered to each subject six months and twelve months after completion of the original experiment.

Five tests of haptic abilities comprised the final test of Concannon's experiment. Testing material consisted of twenty plywood forms of geometric design, each 3/8 inch thick and about 3 inches in width or diameter. The subject put his hands through an opening in a small screen which permitted him to handle the forms handed to him but not to see them. Test 1 required the subject to identify each haptically perceived form by its name or names. Test 2 required the subject to match two identical forms from a series of three forms presented to him haptically. In Test 3 the subject identified each haptic form by selecting a drawing of it from a card containing five line drawings of geometric forms. Test 4 required the drawing of haptically perceived forms, and Test 5 required the subject to describe haptically perceived forms.

The following hypotheses were tested:

1. If pretest scores are controlled, when children who have participated in a program of learning experiences involving haptic perception are tested after a lapse of six and/or twelve months following completion of the program, there is no significant difference between post-test means (for both six and twelve month intervals) in haptic perception scores

   (a) of subjects in individual instruction and subjects in group instruction.

(b) of subjects who attended a modified-Montessori preschool program and subjects who attended a non-Montessori preschool program.

(c) of boys and girls.

(d) of subjects who attended a morning preschool session and subjects who attended an afternoon preschool session.

(e) of subjects who differ in chronological age.

(f) of subjects who differ in mental age.

(g) of subjects who differ in years of schooling received prior to participation in the haptic learning program.

2. When subjects who participated in a program of learning experiences involving haptic perception and subjects who composed the control group for this experiment are tested after a lapse of six and/or twelve months following completion of the program, differences in pre- and post-test means of the experimental group and differences in pre- and post-test means of the control group will not differ significantly when these are analyzed for the following factors:

    (a) type of treatment received in the experimental program.

    (b) type of instruction received in the program.

    (c) type of preschool attended.

    (d) sex.

    (e) session attended in the preschool program.

    (f) chronological age.

    (g) mental age.

    (h) years of schooling received prior to participation in the experimental program.

The general statistical approach to the analysis of the data was a multiple analysis of covariance. In the testing of Hypothesis 1, post-test scores were used as criterion measures. Instruction, school, sex, and session were the four types of independent variables for which main effects were tested, with chronological age, mental age, years in school, and pretest scores taken as concomitant variables. In the testing of Hypothesis 2, change scores, i. e., the differences between pretest and post-test scores, were used as criterion measures. Main effects were tested for five types of independent variables: treatment, instruction, school, sex, and session, with chronological age, mental age, and years in school taken as concomitant variables. The F-ratio (probability level = .05) tested the homogeneity of variance among the means of the dependent variables.

Results

In the follow-up study subjects evidenced considerable retrention of acquired learning and haptic abilities. These results suggested that retention studies should be as helpful in the evaluation and improvement of curricula and methods at the preschool level as they are at higher levels of learning.

Although experimental subjects achieved higher mean scores on the post-tests than did control subjects, control subjects were significantly higher than experimentals in change scores. Experimental subjects had been significantly superior to controls in mean scores and in gain scores at the end of Concannon's experiment. These results were not unexpected. Apparently participation in the haptic learning program had enabled experimental subjects to acquire proficiency in the exercise of haptic abilities and in the use of a vocabulary somewhat more technical and specific than that ordinarily used by preschool children for the identification and description of geometric forms. Usually a retention study shows some loss in this type of proficiency. This loss may even have masked some natural development in haptic perception during the follow-up period. Control subjects, although they had not participated in the haptic learning activities, continued to experience natural development of haptic abilities and to acquire related learning, since opportunities to learn terms, such as names for geometric forms and relationships such as "inside," "outside," etc. are available outside formal learning situations.

Individual and group instruction, which Concannon had found equally effective for learning in her experiment, also proved equally effective when evaluated by measurements made six months and twelve months after completion of the experiment

Apparently preschool programs which rely upon group instruction and preschool programs which stress individual instruction can result in approximately the same amount of learning and retention.

Montessori subjects, who had been superior to non-Montessori subjects in haptic test performance on Concannon's final test, tended to lose their advantage in the course of time. In the follow-up study, non-Montessori subjects achieved significantly higher change scores on several haptic tests than did Montessori subjects. This indicated that, although Montessori subjects had been superior in learning at the end of Concannon's experiment, they had retained relatively less learning during the following year. Future investigations might be designed to validate these findings.

Sex differences in haptic test performance which appeared in Concannon's experiment, tended to diminish and disappear during the follow-up study.

In the follow-up study preschool session attended had no more than a slight, and perhaps negligible, effect on post-test performance. The preschool session attended had not affected learning in Concannon's experiment.

Significant relationships between chronological age and haptic test performance, which had appeared in Concannon's experiment, decreased in the course of time. This may have been due, in part, to the fact that haptic perception is expected to increase as the child grows older and to reach maximum development between the ages of five and eight years. If, during the follow-up study, a number of subjects had attained maximum development of haptic perception, the relationship between this type of perception and chronological age would have decreased.

Mental age had had no significant effect on haptic test performance in Concannon's experiment and made very little contribution to performance on the post-tests. At both intervals of the follow-up study, however, mental age made significant contributions to scores on Test 4, which required the drawing of haptically perceived forms. Possibly the reason no relationship had appeared between mental age and Test 4 in Concannon's experiment was that, at that time, lack of development in motor control had impeded the performance of many subjects on Test 4.

In the follow-up study, years of schooling received prior to participation in Concannon's experiment made no more than a negligible contribution to post-test performance. These findings served to confirm results obtained by Concannon, who found no relationship between previous years of schooling and haptic test performance in her experiment.

Results of the follow-up study suggested several possibilities for further investigations in the retention of learning and the development of haptic perception. Since the relationships of haptic perception to chronological age and to mental age have not, as yet, been thoroughly examined in studies which include statistical verification for findings, an experiment might be designed to investigate these relationships using the haptic forms designed by Concannon and a series of haptic tests which require neither verbalization nor the drawing of haptically perceived forms.

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APPENDIX A

TEST DATA CARD

Follow-up Test Data Card

Name____________________C.A.____Group____Sex____M.A.____Session_____

Address of School________________Years in School________

Geometric Form	Variables Tested									
	I		II		III		IV		V	
	Hap. Iden.		Hap. Iden. & Match.		Hap. Iden. & Form Find.		Hap. Iden. & Rep.		Hap. Iden. & Ver. Char.	
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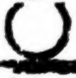
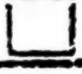
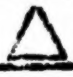
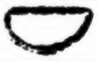
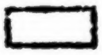
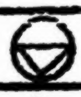
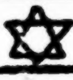
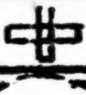
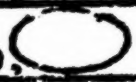
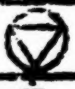
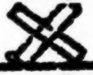
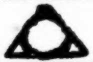
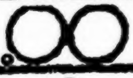
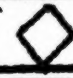
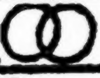
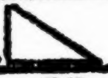
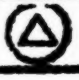
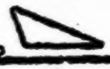
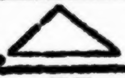
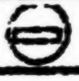
1. 										
2. 										
3. 										
4. 										
5. 										
6. 										
7. 										
8. 										
9. 										
10. 										
11. 										
12. 										
13. 										
14. 										
15. 										
16. 										
17. 										
18. 										
19. 										
20. 										
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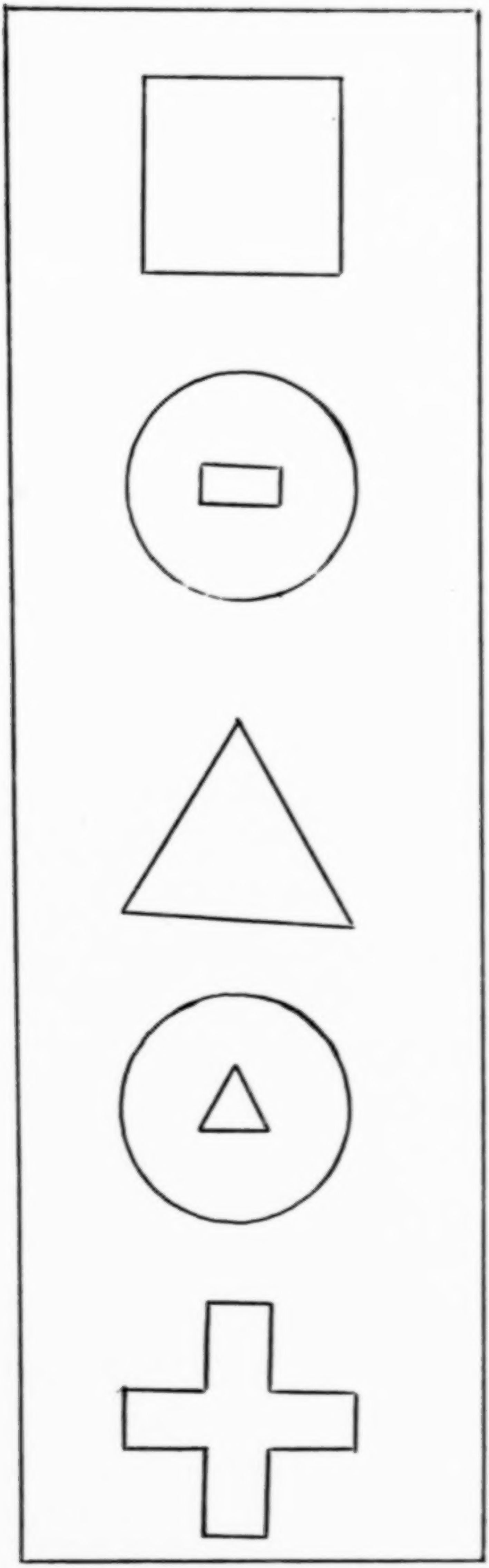
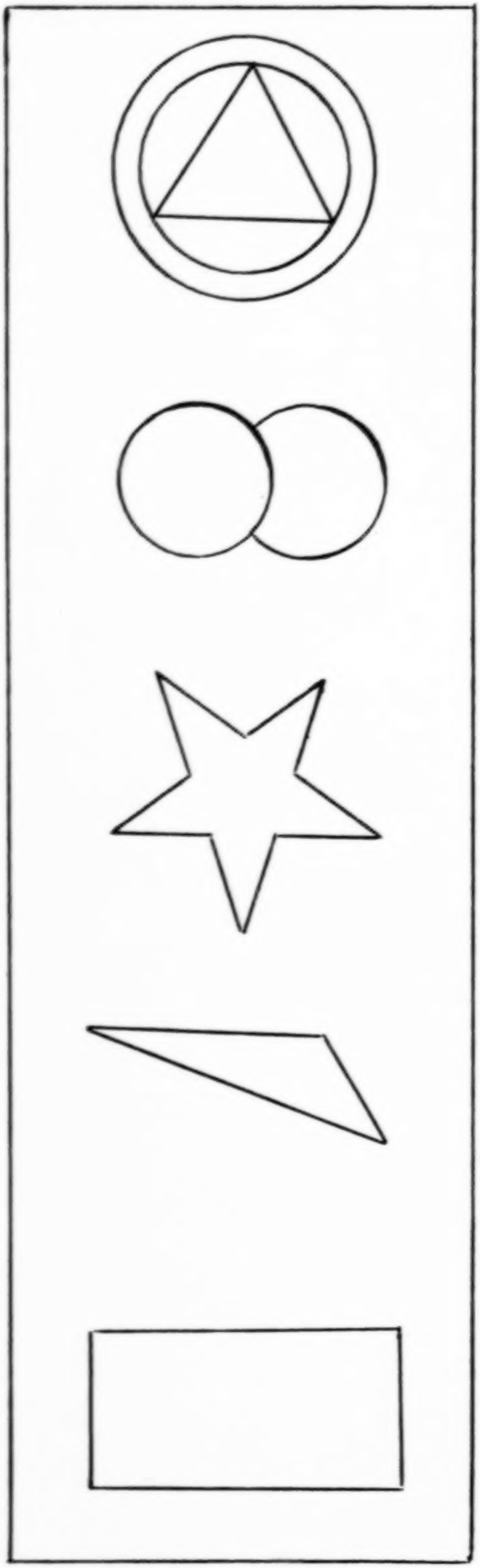
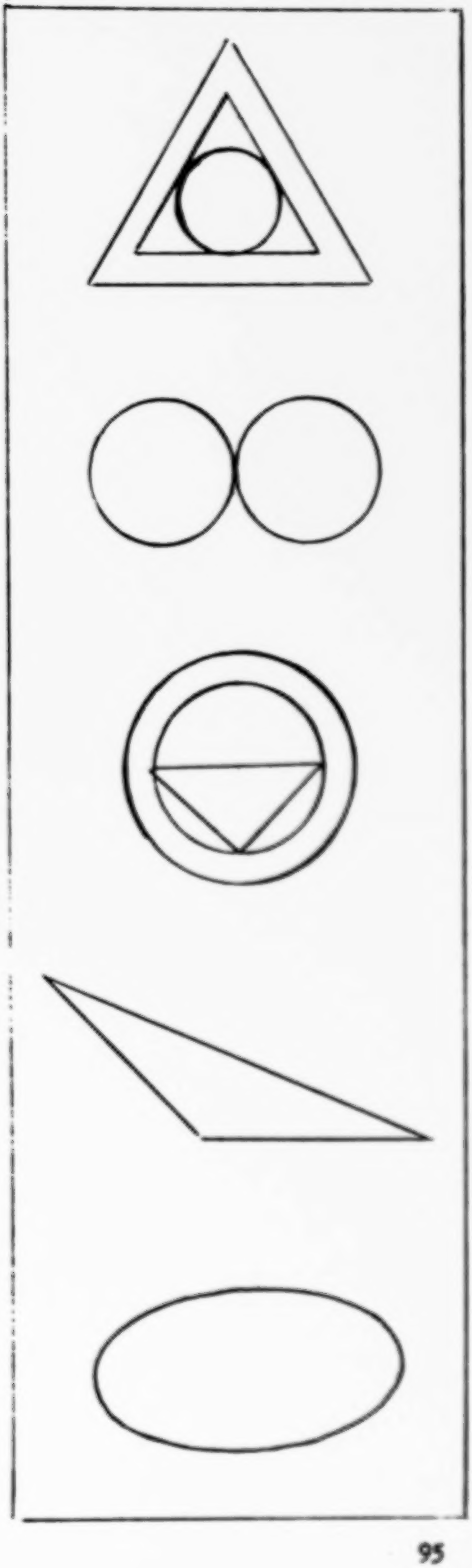
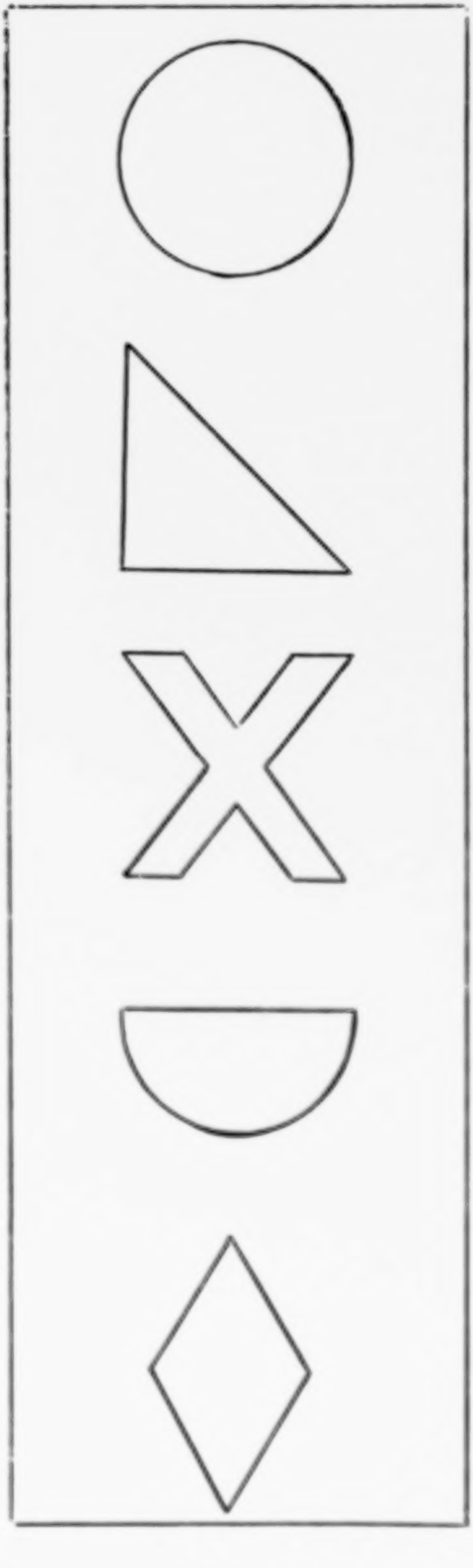
APPENDIX B

REPRODUCTIONS OF CARDS AND DRAWINGS USED IN HAPTIC TEST 3









APPENDIX C

SHEET PROVIDED FOR DRAWINGS IN HAPTIC TEST 4

6 mo. post test____

ild's Name ________________________ School________ 12 mo. post test____

	2	3	4
	6	7	8
	10	11	12
	14	15	16
	18	19	20

APPENDIX D

PRETEST AND POST-TEST MEANS AND STANDARD DEVIATIONS FOR SUBJECTS IN EXPERIMENTAL TREATMENT

TABLE D-1

PRETEST AND POST-TEST MEANS AND STANDARD DEVIATIONS FOR EXPERIMENTAL SUBJECTS IN INDIVIDUAL AND GROUP INSTRUCTION

Test	Pretest		Six months Post-test		Twelve months Post-test	
	$\bar{X}$	σ	$\bar{X}$	σ	$\bar{X}$	σ
Individual (N = 44)						
1	18.14	2.46	15.20	3.89	15.36	3.60
2	17.61	2.87	15.39	3.27	16.00	3.02
3	18.30	1.85	16.43	2.59	16.73	2.82
4	13.98	5.45	11.16	4.91	13.36	4.64
5	18.32	2.48	15.59	3.55	16.52	2.86
Group (N = 44)						
1	17.80	2.48	14.61	5.08	14.86	4.08
2	16.91	3.04	15.25	3.14	16.68	2.89
3	18.18	1.76	16.14	2.64	16.61	2.68
4	13.30	5.50	12.16	4.73	13.11	4.35
5	17.41	3.64	15.27	4.74	16.14	3.65

TABLE D-2

PRETEST AND POST-TEST MEANS AND STANDARD DEVIATIONS FOR EXPERIMENTAL SUBJECTS FROM MONTESSORI AND NON-MONTESSORI PRESCHOOL CLASSES IN INDIVIDUAL AND GROUP INSTRUCTION

Test	Montessori						Non-Montessori					
	Pretest		Six months Post-test		Twelve months Post-test		Pretest		Six months Post-test		Twelve months Post-test	
	$\overline{X}$	σ	$\overline{X}$	σ	$\overline{X}$	σ	$\overline{X}$	σ	$\overline{X}$	σ	X	σ
	Individual (N = 24)						Individual (N = 20)					
1	18.63	2.04	16.42	3.33	15.04	3.93	17.55	2.77	13.75	4.02	15.75	3.11
2	18.13	1.74	15.50	3.42	16.38	2.96	17.00	3.71	15.25	3.08	15.55	3.02
3	18.83	1.46	15.92	2.60	17.25	1.74	17.65	2.06	17.05	2.44	16.10	3.63
4	13.83	5.66	10.79	4.98	13.08	4.55	14.15	5.18	11.60	4.79	13.70	4.72
5	18.96	1.69	16.75	3.00	16.04	3.05	17.55	2.99	14.20	3.66	17.10	2.51
	Group (N = 25)						Group (N = 19)					
1	18.88	1.88	16.32	3.84	15.56	3.45	16.37	2.45	12.37	5.61	13.95	4.63
2	17.44	2.21	15.60	3.20	17.88	1.77	16.21	3.76	14.79	3.00	15.11	3.29
3	18.84	1.12	16.72	2.68	17.48	1.84	17.32	2.05	15.37	2.39	15.47	3.15
4	14.08	5.51	11.80	4.75	13.40	3.76	12.26	5.30	12.63	4.67	12.74	4.99
5	19.44	1.24	16.84	3.52	16.52	2.39	14.74	4.01	13.21	5.32	15.63	4.79

TABLE D-3

PRETEST AND POST-TEST MEANS AND STANDARD DEVIATIONS FOR MALE AND FEMALE EXPERIMENTAL SUBJECTS IN INDIVIDUAL AND GROUP INSTRUCTION

Test	Male						Female					
	Pretest		Six months Post-test		Twelve months Post-test		Pretest		Six months Post-test		Twelve months Post-test	
	$\overline{X}$	σ	$\overline{X}$	σ	$\overline{X}$	σ	$\overline{X}$	σ	$\overline{X}$	σ	$\overline{X}$	σ
	Individual (N = 22)						Individual (N = 20)					
1	18.19	2.30	14.48	3.51	15.10	3.26	18.09	2.59	15.87	4.10	15.61	3.86
2	17.76	2.11	14.95	3.53	15.29	2.68	17.48	3.41	15.78	2.96	16.65	3.16
3	18.52	1.37	15.86	2.78	17.14	1.96	18.09	2.19	16.96	2.27	16.35	3.38
4	13.71	5.62	10.38	4.46	12.90	4.30	14.22	5.27	11.87	5.19	13.78	4.89
5	18.52	2.08	15.05	3.11	16.24	2.51	18.13	2.77	16.09	3.84	16.78	3.13
	Group (N = 20)						Group (N = 24)					
1	18.60	1.80	16.05	4.52	16.15	3.12	17.13	2.76	13.42	5.21	13.79	4.46
2	17.40	2.08	15.85	2.76	17.80	1.57	16.50	3.61	14.75	3.34	15.75	3.37
3	18.65	1.28	16.40	2.96	17.75	2.09	17.79	2.00	15.92	2.33	15.67	2.75
4	14.95	4.25	13.90	3.58	14.20	2.75	11.92	6.01	10.71	5.08	12.21	5.16
5	18.25	2.98	16.85	3.88	17.40	2.37	16.71	3.98	13.96	4.99	15.08	4.16

TABLE D-4

PRETEST AND POST-TEST MEANS AND STANDARD DEVIATIONS FOR EXPERIMENTAL SUBJECTS IN INDIVIDUAL AND GROUP INSTRUCTION DIVIDED BY MORNING AND AFTERNOON PRESCHOOL SESSIONS

Test	Morning Session						Afternoon Session					
	Pretest		Six months Post-test		Twelve months Post-test		Pretest		Six months Post-test		Twelve months Post-test	
	$\overline{X}$	σ	$\overline{X}$	σ	$\overline{X}$	σ	$\overline{X}$	σ	$\overline{X}$	σ	$\overline{X}$	σ
	Individual (N = 22)						Individual (N = 22)					
1	17.91	2.57	15.00	3.40	15.68	2.96	18.36	2.31	15.41	4.32	15.05	4.12
2	17.91	2.50	14.95	3.27	15.82	2.99	18.14	3.11	15.82	3.21	16.18	3.02
3	17.77	1.81	16.09	2.78	17.50	2.11	18.82	1.75	16.77	2.33	15.95	3.21
4	12.82	5.88	9.86	4.83	12.64	4.64	15.14	4.70	12.45	4.65	14.09	4.52
5	17.82	2.84	14.86	3.02	16.27	2.80	18.82	1.92	16.32	3.88	16.77	2.91
	Group (N = 21)						Group (N = 23)					
1	18.52	1.99	16.48	2.99	16.52	2.20	17.13	2.69	12.91	5.93	13.35	4.76
2	17.33	1.96	16.33	2.73	16.76	2.51	16.52	3.73	14.26	3.17	16.61	3.20
3	18.76	1.23	16.67	1.98	17.10	2.62	17.65	1.99	15.65	3.04	16.17	2.66
4	14.38	5.33	13.19	4.18	13.90	3.88	12.30	5.46	11.22	5.00	12.39	4.62
5	18.19	2.89	17.00	2.47	17.43	2.08	16.70	4.08	13.70	5.68	14.96	4.32

APPENDIX E

ADDITIONAL TABLES OF THE ANALYSIS OF COVARIANCE FOR POST-TEST MEANS

TABLE E-1

ANALYSIS OF COVARIANCE FOR POST-TEST MEANS OF EXPERIMENTAL MONTESSORI AND NON-MONTESSORI SUBJECTS IN INDIVIDUAL INSTRUCTION

Interval	Test	Post-test Means				F	p
		Montessori (N = 24)		Non-Montessori (N = 20)			
		$\bar{X}$	σ	$\bar{X}$	σ		
Six months	1	16.42	3.33	13.75	4.02	2.26	>.05
	2	15.50	3.42	15.25	3.08	0.00	>.05
	3	15.92	2.60	17.05	2.44	0.66	>.05
	4	10.79	4.98	11.60	4.79	0.66	>.05
	5	16.75	3.00	14.20	3.66	3.84	>.05
Twelve months	1	15.04	3.93	15.75	3.11	2.33	>.05
	2	16.38	2.96	15.55	3.02	2.03	>.05
	3	17.25	1.74	16.10	3.63	1.79	>.05
	4	13.08	4.55	13.70	4.72	0.67	>.05
	5	16.04	3.05	17.10	2.51	1.61	>.05

TABLE E-2

ANALYSIS OF COVARIANCE FOR POST-TEST MEANS OF EXPERIMENTAL MONTESSORI AND NON-MONTESSORI SUBJECTS IN GROUP INSTRUCTION

		Post-test Means					
Interval	Test	Montessori (N = 25)		Non-Montessori (N = 19)		F	p
		$\bar{X}$	σ	$\bar{X}$	σ		
Six months	1	16.32	3.84	12.37	5.61	2.69	$>.05$
	2	15.60	3.20	14.79	3.00	.03	$>.05$
	3	16.72	2.68	15.37	2.39	.91	$>.05$
	4	11.80	4.75	12.63	4.67	7.92	$<.01$
	5	16.84	3.52	13.21	5.32	.59	$>.05$
Twelve months	1	15.56	3.45	13.95	4.63	.14	$>.05$
	2	17.88	1.77	15.11	3.29	9.19	$<.01$
	3	17.48	1.84	15.47	3.15	3.87	$>.05$
	4	13.40	3.76	12.74	4.99	1.11	$>.05$
	5	16.52	2.39	15.63	4.79	1.43	$>.05$

TABLE E-3

ANALYSIS OF COVARIANCE FOR POST-TEST MEANS OF MALE AND FEMALE EXPERIMENTAL SUBJECTS IN INDIVIDUAL INSTRUCTION

Interval	Test	Post-test Means				F	P
		Male (N = 21)		Female (N = 23)			
		$\bar{X}$	σ	$\bar{X}$	σ		
Six months	1	14.48	3.51	15.87	4.10	4.53	$<.05$
	2	14.95	3.53	15.78	2.96	1.36	$>.05$
	3	15.86	2.78	16.96	2.27	3.34	$>.05$
	4	10.38	4.46	11.87	5.19	4.00	$<.05$
	5	15.05	3.11	16.09	3.84	3.18	$>.05$
Twelve months	1	15.10	3.26	15.61	3.86	.62	$>.05$
	2	15.29	2.68	16.65	3.16	5.20	$<.05$
	3	17.14	1.96	16.35	3.38	.33	$>.05$
	4	12.90	4.30	13.78	4.89	.88	$>.05$
	5	16.24	2.51	16.78	3.13	1.06	$>.05$

TABLE B-4

ANALYSIS OF COVARIANCE FOR POST-TEST MEANS OF MALE AND FEMALE EXPERIMENTAL SUBJECTS IN GROUP INSTRUCTION

Interval	Test	Post-test Means				F	p
		Male (N = 20)		Female (N = 24)			
		$\bar{X}$	σ	$\bar{X}$	σ		
Six months	1	16.05	4.52	13.42	5.21	.33	>.05
	2	15.85	2.76	14.75	3.34	.06	>.05
	3	16.40	2.96	15.92	2.33	.08	>.05
	4	13.90	3.58	10.71	5.08	.70	>.05
	5	16.85	3.88	13.96	4.99	1.83	>.05
Twelve months	1	16.15	3.12	13.79	4.46	.61	>.05
	2	17.80	1.57	15.75	3.37	2.39	>.05
	3	17.75	2.09	15.67	2.75	2.83	>.05
	4	14.20	2.75	12.21	5.16	.18	>.05
	5	17.40	2.37	15.08	4.16	1.23	>.05

TABLE E-5

ANALYSIS OF COVARIANCE FOR POST-TEST MEANS OF EXPERIMENTAL SUBJECTS FROM MORNING AND AFTERNOON PRESCHOOL SESSIONS IN INDIVIDUAL INSTRUCTION

Interval	Test	Post-test Means				F	p
		Morning (N = 22)		Afternoon (N = 22)			
		$\bar{X}$	σ	$\bar{X}$	σ		
Six months	1	15.00	3.40	15.41	4.32	.00	$>.05$
	2	14.95	3.27	15.82	3.21	.24	$>.05$
	3	16.09	2.78	16.77	2.33	.06	$>.05$
	4	9.86	4.83	12.45	4.65	2.27	$>.05$
	5	14.86	3.02	16.32	3.88	.61	$>.05$
Twelve months	1	15.68	2.96	15.05	4.12	.85	$>.05$
	2	15.82	2.99	16.18	3.02	.00	$>.05$
	3	17.50	2.11	15.95	3.21	6.81	$<.05$
	4	12.64	4.64	14.09	4.52	.00	$>.05$
	5	16.27	2.80	16.77	2.91	.01	$>.05$

TABLE E-6

ANALYSIS OF COVARIANCE FOR POST-TEST MEANS OF EXPERIMENTAL SUBJECTS FROM MORNING AND AFTERNOON PRESCHOOL SESSIONS IN GROUP INSTRUCTION

Interval	Test	Post-test Means				F	p
		Morning (N = 22)		Afternoon (N = 23)			
		$\overline{X}$	σ	$\overline{X}$	σ		
Six months	1	16.48	2.90	12.91	5.93	4.20	<05
	2	16.33	2.73	14.26	3.17	2.47	>.05
	3	16.67	1.98	15.65	3.04	.07	>.05
	4	13.19	4.18	11.22	5.00	.00	>.05
	5	17.00	2.47	13.70	5.68	4.74	<05
Twelve months	1	16.52	2.20	13.35	4.76	4.17	<05
	2	16.76	2.51	16.61	3.20	.33	>.05
	3	17.10	2.62	16.17	2.66	.20	>.05
	4	13.90	3.88	12.39	4.62	.04	>.05
	5	17.43	2.08	14.96	4.32	2.87	>05

APPENDIX F

PRETEST AND POST-TEST MEANS AND STANDARD DEVIATIONS FOR SUBJECTS IN EXPERIMENTAL AND CONTROL TREATMENTS

TABLE F-1

PRETEST AND POST-TEST MEANS AND STANDARD DEVIATIONS FOR EXPERIMENTAL AND CONTROL SUBJECTS FROM MONTESSORI AND NON-MONTESSORI PRESCHOOL CLASSES

Test	Montessori						Non-Montessori					
	Pretest		Six months Post-test		Twelve months Post-test		Pretest		Six months Post-test		Twelve months Post-test	
	$\bar{X}$	σ	$\bar{X}$	σ	$\bar{X}$	σ	$\bar{X}$	σ	$\bar{X}$	σ	$\bar{X}$	σ
	Experimental (N = 49)						Experimental (N = 39)					
1	18.76	1.96	16.37	3.60	15.31	3.70	16.97	2.68	13.08	4.91	14.87	4.03
2	17.78	2.02	15.55	3.31	17.14	2.54	16.62	3.76	15.03	3.05	15.33	3.16
3	18.84	1.30	16.33	2.67	17.37	1.79	17.49	2.06	16.23	2.56	15.79	3.42
4	13.96	5.59	11.31	4.89	13.24	4.17	13.23	5.32	12.10	4.76	13.23	4.88
5	19.20	1.50	16.80	3.28	16.29	2.74	16.18	3.80	13.72	4.57	16.38	3.87
	Control (N = 23)						Control (N = 20)					
1	10.74	5.14	10.78	4.02	12.87	3.35	9.65	6.23	8.85	5.52	11.45	5.01
2	13.65	5.36	12.87	3.76	15.96	2.94	13.75	5.22	13.55	3.32	14.20	2.94
3	14.83	5.66	13.30	3.08	15.87	2.25	12.00	4.80	14.05	4.74	14.35	3.48
4	5.00	3.32	7.78	4.33	11.30	3.53	6.50	5.28	7.55	5.31	10.20	5.44
5	9.48	4.36	10.91	3.97	13.52	3.62	9.00	5.94	9.20	5.38	13.25	4.64

TABLE F-2

PRETEST AND POST-TEST MEANS AND STANDARD DEVIATIONS FOR MALE AND FEMALE SUBJECTS IN EXPERIMENTAL AND CONTROL TREATMENTS

Test	Male						Female					
	Pretest		Six months Post-test		Twelve months Post-test		Pretest		Six months Post-test		Twelve months Post-test	
	$\bar{X}$	σ	$\bar{X}$	σ	$\bar{X}$	σ	$\bar{X}$	σ	$\bar{X}$	σ	$\bar{X}$	σ
	Experimental (N = 41)						Experimental (N = 47)					
1	18.39	2.08	15.24	4.11	15.61	3.24	17.60	2.72	14.62	4.86	14.68	4.28
2	17.59	2.11	15.39	3.21	16.51	2.54	16.98	3.55	15.26	3.21	16.19	3.20
3.	18.59	1.32	16.12	2.88	17.44	2.05	17.94	2.10	16.43	2.36	16.00	3.09
4	14.32	5.04	12.10	4.42	13.54	3.68	13.04	5.78	11.28	5.17	12.98	5.09
5	18.39	2.57	15.93	3.62	16.80	2.51	17.40	3.51	15.00	4.59	15.91	3.79
	Control (N = 23)						Control (N = 20)					
1.	8.87	5.63	9.39	4.74	11.43	3.94	11.80	5.37	10.45	4.95	13.10	4.45
2	12.39	6.30	12.78	4.16	14.70	2.61	15.20	3.25	13.65	2.69	15.65	3.12
3	12.17	6.29	13.43	3.79	15.04	2.82	15.05	3.77	13.90	4.13	15.30	3.16
4	4.91	4.52	6.17	5.06	10.04	4.78	6.60	4.09	9.40	3.84	11.65	4.11
5	8.70	5.29	9.35	4.50	12.39	4.16	9.90	4.94	11.00	4.89	14.55	3.77

TABLE F-3

PRETEST AND POST-TEST MEANS AND STANDARD DEVIATIONS FOR EXPERIMENTAL AND CONTROL SUBJECTS FROM MORNING AND AFTERNOON PRESCHOOL SESSIONS

Test	Morning Session						Afternoon Session					
	Pretest		Six months Post-test		Twelve Months Post-test		Pretest		Six months Post-test		Twelve months Post-test	
	$\bar{X}$	σ	$\bar{X}$	σ	$\bar{X}$	σ	$\bar{X}$	σ	$\bar{X}$	σ	$\bar{X}$	σ
	Experimental (N = 43)						Experimental (N = 45)					
1	18.21	2.33	15.72	3.29	16.09	2.65	17.73	2.59	14.13	5.36	14.18	4.54
2	17.21	2.26	15.63	3.10	16.28	2.81	17.31	3.53	15.02	3.28	16.40	3.12
3	18.26	1.63	16.37	2.44	17.30	2.38	18.22	1.97	16.20	2.78	16.07	2.95
4	13.58	5.67	11.49	4.82	13.26	4.33	13.69	5.29	11.82	4.87	13.22	4.65
5	18.00	2.87	15.91	2.96	16.84	2.54	17.73	3.38	14.98	5.05	15.84	3.81
	Control (N = 21)						Control (N = 22)					
1	9.86	5.88	9.90	5.34	12.76	4.00	10.59	5.50	9.86	4.38	11.68	4.45
2	12.76	5.81	13.24	4.28	15.24	3.08	14.59	4.59	13.14	2.75	15.05	2.70
3	13.33	5.82	13.67	4.26	16.14	2.40	13.68	5.09	13.64	3.65	14.23	3.19
4	5.29	4.39	8.10	5.07	10.95	5.05	6.09	4.39	7.27	4.51	10.64	4.02
5	8.95	6.02	9.86	5.16	13.67	4.02	9.55	4.16	10.36	4.32	13.14	4.21

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ABSTRACT

A study was conducted to assess the combined effects of the retention of learning and the development of haptic perception in 131 of the 144 preschool subjects who had participated in Concannon's haptic learning experiment. Haptic perception, according to Piaget, is the ability to recognize objects by the sense of touch alone in the absence of visual stimulation. The final test of Concannon's experiment was the pretest of the follow-up study and was administered as post-tests six months and twelve months after completion of Concannon's experiment. Results indicated that subjects had retained a considerable amount of learning and proficiency in haptic abilities. Individual and group instruction were equally effective. Experimental subjects received higher post-test means than did controls but controls achieved significantly higher change scores, i. e., differences between pretest and post-test scores. Montessori subjects tended to lose the superiority they had attained over non-Montessori subjects. Sex, preschool session attended, and years of schooling received prior to participation in Concannon's experiment had little or no effect on post-test performance. The relationship found by Concannon between chronological age and haptic test performance decreased. Mental age had little or no relationship to performance on most of the haptic tests, but made a significant contribution to the drawing of haptically perceived forms. In general, differences in test performance, found in Concannon's experiment, tended to diminish and, sometimes, to disappear after a lapse of six or twelve months.